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Volume XXII
Third Memoir

FOSSIL LIZARDS OF NORTH AMERICA

by

Charles W. Gilmore
1928

With an Introduction

by

Richard D. Estes

and a Foreword

by

Robert M. Sullivan and John F. Wear

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FOREWORD

Nineteen seventy-eight marks the fiftieth anniversary of the publication of Charles Whitney Gilmore's *Fossil Lizards of North America.*

The Riverside Museum is indeed honored to reprint this classic monograph, through the Riverside Museum Press, in its original form with an introduction by Dr. Richard D. Estes on the advances in paleoherpetology since Gilmore's study.

Charles Whitney Gilmore (1874-1945) was one of the world's foremost authorities on dinosaurs as well as the recognized authority of his day on fossil lizards. He was inspired at an early age to pursue a museum-oriented career. Leaving his native Michigan, he enrolled at the University of Wyoming where he became involved in studying dinosaurs, an interest that was to occupy him the rest of his life. Upon his graduation from the university in 1901, he was appointed Collector and Preparator of Fossils by the Carnegie Museum (Pittsburgh). In 1903 he became affiliated with the Division of Vertebrate Paleontology, United States National Museum, Smithsonian Institution, where he stayed until his death, rising through the ranks from Preparator to Curator of Vertebrate Paleontology in 1923.

Between 1902 and 1945, Charles W. Gilmore published more than 170 papers, most of which dealt with fossil reptiles. Of these publications, *Fossil Lizards of North America* stands as one of the most important. It remains today a major reference for vertebrate paleontologists and herpetologists alike.

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INTRODUCTION

The publication in 1928 of Charles Whitney Gilmore's monograph *Fossil Lizards of North America* brought together in a systematic way scattered descriptions by earlier workers as well as new ones for more recently collected material. Although now outdated, Gilmore's work is so thoroughly documented that it is an invaluable reference on research results up to the late 1920's. Generally unavailable for some years, its hard-cover reprint represents an important contribution to paleoherpetology and to numerous libraries that lack this monograph.

The first species of North American fossil lizard to be described, based on a specimen from the Eocene of Wyoming, was made by Joseph Leidy in 1870. Although this specimen was not fully prepared at that time, Leidy was able to recognize its affinities with the living varanid lizards and named it *Saniwa ensidens* (Leidy 1870). Following closely on Leidy's heels came other descriptions from the notable paleontological rivals E. D. Cope and O. C. Marsh, each of whom named other genera and species of fossil lizards from North America, based on fossils from their collections of the late 1860's and early 1870's. Cope, in particular, was a perceptive student of living lizards, although in the haste that characterized many Cope and Marsh studies, little of his knowledge of reptilian anatomy and classification came through. Descriptions of fossil lizards by both Cope and Marsh were about equally inadequate and were based for the most part on very fragmentary material. Marsh applied several names to material that he surely must have realized was undiagnostic to species, such as abraded caudal vertebrae. Although Marsh occasionally mistook fish teeth for those of mammals and Cope named sharks based on salamander vertebrae and mistook sturgeon scutes for lungfish teeth, all of their lizards taxa were, in fact, based on lizard remains. Their early work on fossil lizards was published in papers dated principally 1871-1873, and quite a number of their names are *nomina dubia* or synonyms today. Among genera still considered valid, Marsh was responsible for *Glyptosaurus* and *Tinosaurus;* Cope for *Aciprion*, *Exostinus*, *Peltosaurus* and *Xestops.*

Fifty years later, C. W. Gilmore began work on the few North American fossil lizards described up to that time as well as on the relatively far superior unpublished materials that had been collected subsequently. Gilmore's many studies on dinosaurs and other archosaurian reptiles form the major body of his work, yet his monograph on fossil lizards was the first attempt to organize the study of fossil lizards, and it was strikingly successful for its time, reflecting Gilmore's careful approach and commitment to what often was very scrappy material, indeed. I do not know what started him on the project, but it coincided with the exciting synthetic work on lizard classification then being done by Charles L. Camp at the American Museum of Natural History. Gilmore noted, in his monograph, that he had a copy of Camp's dissertation on lizard anatomy and classification "long in advance of its publication" in 1923. He also had quite a number of United States National Museum lizard fossils available to him. These fossils, along with the advice and encouragement of the herpetologist at the United States National Museum, Leonard Stejneger, may have prompted his interest. His interest in fossil lizards did not stop with the publication of his monograph, and his work in this area and on fossil snakes continued up to the time of his death. In particular, his work on the large Cretaceous lizard *Polyglyphanodon* (1942) and on Mongolian fossil lizards (1943) dates from his later period. Indeed, most of the reports on North American fossil lizards published from 1928 to 1943 we owe to Gilmore.

The next chapter in paleoherpetology was complementary to, not a continuation of, Gilmore's work. It was initiated by Robert Hoffstetter at the National Museum in Paris. In 1942, Hoffestetter began a series of papers clarifying the history of European fossil lizards. His principal contributions in this field have been his general summaries of 1955 and 1962 and his studies on Jurassic lizards of 1964 and 1967. Although his interests in fossil lizards continues, he now works primarily with fossil mammals. His work in European paleoherpetology is being continued by Jean-Claude Rage (Université de Paris), whose work, to date, however, has been primarily with frogs and snakes. Marian Młynarski (Krákow) and Andrzej Sulimski (Warsaw) are among other current workers on European lizard fossils.

Following the stimulating discussion of anguimorph lizards by McDowell and Bogert (1954), other studies on this important group of lizards have been made and are in progress. Meszoely (1970,) Meszoely and Haubold (1975) and Meszoely, Estes and Haubold (1978) have dealt with various anguid groups, and Robert Sullivan has revised *Glyptosaurus* in a study that I hope will be published soon. The glyptosaurs are an important and common group of fossil lizards, particularly in the North American Eocene and Oligocene. Gilmore's pioneer work on this group was important in that he provided more adequate figures and descriptions of this group than had been previously available. The same is true for *Peltosaurus*, another common Oligocene glyptosaurine, based on disarticulated materials by Cope but now known by a number of complete skulls. Notable progress also has been made in the fossil record of helodermatids. Gilmore did have a Recent *Heloderma* skeleton and was able to describe *H. matthewi* based on a very poorly preserved maxillary fragment. His identification has been shown to be correct through study of better material by Yatkola (1976), who has synonymized the Eocene-Oligocene *Eurheloderma* with the Recent genus. The astonishing presence of the former in Europe was described by Hoffstetter (1957). As noted above, varanids had been recognized in North America since Leidy (1870). Gilmore had this material prepared and gave a careful account of *Saniwa ensidens*. Long believed to be representative of a different subfamily of varanids, it is simply a primitive species of *Varanus*, lying in the range of variation of the rather broad and diverse living representatives of the genus. Gilmore also names two Cretaceous North American forms that he considered varanids. Of these, I included *Parasaniwa* in a new family Parasaniwidae (Estes 1964) and accepted *Palaeosaniwa* as a varanid. Current studies by Jacques Gauthier at the University of California, Berkeley, have shown that *Parasaniwa* is related to *Necrosaurus* from the French Eocene, a genus briefly discussed by Hoffstetter (1954) but still not adequately described or figured. The Necrosauridae occupies the same approximate position as envisioned by Estes (1964) for the Parasaniwidae, intermediate between Anguioidea and Varanoidea. Currently, Gauthier is preparing a major revision of the basis of classification of the Anguimorpha.

The amphisbaenoid lizards were recognized in the Oligocene of North America by Cope, and Gilmore redescribed the rather good material of *Rhineura hatcheri* originally named by Georg Baur (1893), at one time one of Marsh's many assistants and unacknowledged collaborators. Up to the time of Gilmore's writing, *R. hatcheri* was the only amphisbaenoid represented by skull material, and Gilmore also followed the suggestion of E.R. Dunn to include the genus *Ototriton* in the group. Recent work on fossil amphisbaenids has been reported by David Berman (1976), the most active recent worker on fossil amphisbaenoids. He has revised or is revising most available materials of the rhineurine group.

As Gilmore, himself, would have acknowledged, his "Sauria of unknown family reference" has been the least successful aspect of his work, although the material was fragmentary and he did draw attention to some interesting problems by naming a number of forms that he believed might be valid. Most of them have proved synonymous with other forms, and *nomina dubia*, or are not referable to Lacertilia. One of his *incertae sedis* group, however, is of notable interest. *Cteniogenys*, from the Late Jurassic of Wyoming, was included in his monograph although he suggested that is might eventually prove to be referable to Amphibia. After comparison of the material of *Cteniogenys* with some of the Triassic fissure material being studied by Pamela Robinson in London, I determined that *Cteniogenys* was a late surviving eolacertilian. Much to my delight, I found on a visit to the Freie Universitat Berlin that Jurgen Seiffert had described extensive material of *Cteniogenys* from the Portuguese Jurassic and that it was indeed an eolacertilian. Unfortunately, Seiffert's monograph remains "in press" in Portugal several years since its completion.

While this introduction is not the place for an evaluation of work in paleoherpetology since Gilmore (1928), I think it useful to discuss briefly some of the major groups of lizards for which a fossil record is available in order to consider North American paleoherpetological studies in a more meaningful context and to cite some advances in the knowledge of each group.

With respect to the Iguania, it is necessary to mention the obvious fact that to study fossil lizards one needs extensive collections of recent lizard skeletons. In early stages of my own work on fossil lizards, I went to the United States National Museum to use Gilmore's osteological material of Recent lizards. Doris Cochran, then Curator of Amphibians and Reptiles, opened a small cabinet in her office for me. "There" she said with some reserve, "is Gilmore's skeleton collection". My admiration for what Gilmore had accomplished underwent an immediate quantum leap, for there were perhaps 12-15 small boxes and a very large, dusty and ligamentary *Iguana* skeleton. The boxes proved to contain individual skeletons of some of the more common lizards, but there was little cosmopolitan flavor. After a pleasant conversation about other herpetological matters, I indicated to Dr. Cochran that since the collection was so small, I would not stay to examine it further. "They never do," she said, with a gracious smile.

Since Gilmore's time osteological knowledge of the Iguanoid lizards has vastly increased, in great part the result of studies by Richard Etheridge, who is collaborating with me on Early and Middle Cenozoic iguanids. In spite of his poor sample of skeletons, Gilmore did correctly assign the genera *Aciprion* and *Parasauromalus* to the Iguanidae. The former is now known by a number of skulls and seems to have its greatest resemblances to the basiliscine iguanids; the latter is a primitive iguanid with some similarities to the iguanine genera but considerably more primitive than that group. Gilmore followed earlier workers in considering the Cretaceous *Chamops* and *Exostinus* to be iguanids, although they are now placed in the Teiidae and Xenosauridae, respectively. In his later study on *Polyglyphanodon*, he allied this form with the Iguania. (I believe that if he had the skeleton of a large teiid such as *Tupinambis* had been available to him, his assessment of *Polyglyphanodon* would have been different.) *Polyglyphanodon* has been linked to the teiids independently by S. B. McDowell and myself, as well as by Robert Hoffstetter, as the latter noted in 1962. Whether it is in that family or a closely-related family of its own must await future work. He also continued placement of *Tinosaurus* as a chamaeleontid, although it is probably an agamid. New material of the Mongolian Cretaceous genus *Mimeosaurus*, now being studied in Warsaw by Magdalena Borsuk-Białynicka, may help to solve this problem.

One of the potentially most important sources of new data on fossil scincomorphs is the magnificent series of skeletons from the Cretaceous of Mongolia that has been obtained by the joint Polish-Mongolian expeditions of recent years. The published work so far (e.g., Sulimski 1975) has revealed the structure of some primitive scincomorph lizards that rather broadly link the presently South American Teiidae with the Asian scincomorph radiation. The Mongolian forms include less specialized members of the polyglyphanodontid lizards, closely related to the North American *Polyglyphanodon*, described by Gilmore from the Cretaceous of Utah and referred by him to the Iguania. *Polyglyphanodon* has been discovered recently in Baja California; thus, this lineage was rather widely distributed in the Late Mesozoic. Disarticulated material from the Wyoming and Montana Cretaceous has been referred to the Teiidae (Estes 1964, 1969) and I still believe it to be in or closely related to that family. Articulated material of these latter forms is necessary, however, to determine their relationship to the polyglyphanodontids.

At the beginning of his monograph, Gilmore included a section on the origin of lizards, which represented the best information available at that time. Some years later Camp (1945) believed that in *Prolacerta* he saw the beginnings of the lizard lineage; Gilmore's speculations (which were admittedly not based on his own work) were thus outdated. As Triassic material referable to what Pamela Robinson has called the Eolacertilia has accumulated (Robinson 1967), and since Gow (1975) has revised *Prolacerta*, it has become clear that the latter is representative of a group of diapsids that independently achieved streptostyly, and that the earliest lizards are to be found among small, insectivorous forms such as *Paleagama* and *Paliguana* (Carroll 1977) from the Late Permian and Early Triassic of Africa, primitive members of the Eolacertilia. Thus, perhaps lizard origins are to be sought among small Permian diapsids not yet discovered. Carroll and Galton (1977) have described *Fulengia*, from the Triassic of China and referred it to the Lacertilia, although I believe it to be more primitive than that group. By the late Jurassic, lizards referable to living superfamilies are known and have been carefully analyzed by Hoffstetter (1964, 1967). Gekkota, Scincoiedea, Anguimorpha and (with less certainty) Iguania are present, although it appears that these animals cannot be placed in the living families without altering the definition of these groups. By the Late Cretaceous, most of the major families have appeared (Estes 1969).

In this brief summary of recent knowledge about the fossil record of lizards, I have necessarily had to omit many important papers and the names of numerous workers on fossil lizards. What I have attempted to document, at least in part, are the major events and viewpoints that highlight the time since the publication of Gilmore's monograph, which certainly marks a turning point in paleoherpetology. Prior to his work there was little of substance; after it the outline of the record was available, and subsequently there has emerged a clearer outline of the general sequence of events in lizard evolution (see e.g. Carroll 1977); there must be included as well considerable work on the living fauna that of necessity has not even been hinted at in this summary, but much of which has been summarized by Underwood (1971). We now stand at a point when new techniques of analysis such as those utilized by Moffat (1973) and Kluge (1976) will be applied more and more to the living groups of lizards. As additional fossil data comes in, it can be integrated into a rigorous, consistent scheme of lizard systematics that I believe will be available within the next ten years. This scheme will be based on careful analysis of osteological data and also will include the information currently being acquired, for example, on karyotypes and biochemical patterns. I now see the approach of another turning point in paleoherpetoloty.

Richard D. Estes
San Diego State University
June, 1978

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BY

CHARLES W. GILMORE

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FOSSIL LIZARDS OF NORTH AMERICA

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INTRODUCTION

In 1870, Prof. Joseph Leidy described the first true fossil lizard from North America, and during the half century that has since elapsed some 42 species, pertaining to 19 genera, have been proposed. Leidy, Cope, and Marsh were the principal students of this group of extinct North American Reptilia, most of their contributions appearing prior to 1875. A few scattering articles followed, which, with two short papers by Mr. Earl Douglass of the Carnegie Museum and two by Dr. F. B. Loomis of Amherst College in recent years, sum up all that has been written on the fossil land lizards of this country.

In the preparation of the present work I have, through the generous cooperation of those in charge of the collections, been enabled to bring together in the United States National Museum all of the fossil lizard remains known from North America. This assemblage, including the original types as well as unstudied material, constitutes perhaps the largest and most important collection of fossil lacertilians ever at the disposal of a single investigator. I have thus been able to examine all of the original types with the exception of three, i. e., *Saniwa major* Leidy, *Naocephalus porrectus* Cope, and *Thinosaurus paucidens* Marsh; these are either lost or have been temporarily misplaced. Leidy's *Tylosteus ornatus*, *Palaeoscincus costatus*, and *Troödon formosus*, though originally referred to the Lacertilia, are now known to belong to the Dinosauria and are thus dropped from further consideration. The great advantage of having these type materials assembled for direct comparison and study is at once apparent, particularly since only 16 of the 42 described species have been illustrated, and of these not more than one-half adequately so.

It is perhaps needless to refer to the very fragmentary character of a majority of the original types. The subsequent discovery of better and more fully preserved specimens has, in several instances, enabled me to more firmly establish certain forms, and in a few cases to clearly demonstrate their relationships to living members of the group. It was, however, disappointing to find so few well-preserved specimens among the accumulations of many years' explorations. That well-preserved lizard remains are so rarely found may be attributed to the fact that, exclusive of the Mosasauridae and a few other extinct water-living forms, they have been largely terrestrial in habit, and in all probability seldom frequented even the vicinity of water. The great majority of extant lizards live only in high and dry places, though some are denizens of low and swampy land, a few even being not averse to the water.

The study of fossil lizards is made more difficult by the dearth of adequate descriptions of the osteological anatomy of the living forms. The characterization of genera and species in modern lizards has been largely made on the arrangement, number, etc., of the head and body scales, combined with features of the soft anatomy—all characters which are practically useless for the purposes of the paleontologist. Much better results would doubtless have been attained had this study been carried on jointly with a herpetologist. Dr. Leonhard Stejneger, head curator of biology in the United States National Museum, has, however, not only contributed his time and knowledge to aid me in the proper classification of some of these fragmentary fossils, but has had numerous examples of existing lizards skeletonized, without which it would have been impossible to carry out a systematic study of the extinct forms.

In the present study attention has been given more to the assembling and recording in this one article of all available information and facts relating to the extinct Sauria rather than to unproductive speculation as to the origin and phyletic or other relationships of the group. The material at hand, though fragmentary, promises much for the future, and the idea uppermost in the present compilation is the establishment of a foundation upon which to build. If successful in this, I shall feel that substantial progress has been made toward a better understanding of the extinct Sauria of the North American Continent.

I wish here to acknowledge my indebtedness to the following individuals and the organizations with which they are connected for their ready response to my requests for the loan of specimens: Prof. Charles Schuchert and Dr. R. S. Lull, of Yale University; Dr. W. D. Matthew, of the American Museum of Natural History; Dr. W. J. Holland, former director, and Dr. Douglass Stewart, late director, of the Carnegie Museum; Dr. W. J. Sinclair, of Princeton University; Dr. Witmer Stone, Philadelphia Academy of Natural Sciences; Dr. E. M. Kindle, of the Canadian Geological Survey; Mr. E. S. Riggs, Field Museum of Natural History; Dr. John A. Allan and Mr. L. S. Russell, University of Alberta; Mr. Paul Miller, Walker Museum of the University of Chicago; Mr. Handel T. Martin, of the University of Kansas; Dr. Chester Stock, University of California; and Dr. F. B. Loomis, Amherst College.

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My greatest obligation, however, is to Dr. John C. Merriam and his associates on the Marsh fund committee of the National Academy of Sciences for the generously furnished financial support which made this research possible.

HISTORICAL REVIEW OF DISCOVERIES OF SAURIA IN NORTH AMERICA

All of the fossil lizard remains known from North America, if the Mosasauria are excluded, have been discovered as an incidental part of the work of various expeditions organized either for geological exploration or for the collecting of other classes of fossil vertebrates. Nowhere is there record of the organization of an expedition having as its primary object the securing of lizard specimens. The reason for this, however, is easily understood when their small size, rarity, and usually fragmentary condition are considered.

The earliest reference found of fossils ascribed to the Lacertilia is in 1856, when Dr. Joseph Leidy,[1] in describing *Paleoscincus costatus* and *Troödon formosus*, regarded them as having their affinities with the lacertilian reptiles. It is now known that he was in error in this as both clearly belong to the Dinosauria.

To Dr. E. D. Cope is probably due the credit for the first discovery of saurian remains in North America, if the Mosasauria are excluded. In a communication read before the Philadelphia Academy of Natural Sciences on April 11, 1867, he reported his discovery of two representatives of the Lacertilia in the Wasatch, Lower Eocene, of New Mexico. He later identified one of these as pertaining to the Placosauridae of Gervais. Through the discovery of other and better preserved specimens, this is now known to belong to the genus *Glyptosaurus*, established by Marsh some years after the first discovery.

In 1870 Dr. F. V. Hayden made a geological reconnaissance through Wyoming, an itinerary which included the Green River Basin where he made collections of fossil vertebrate remains. Some, if not all of these, were submitted to Dr. Joseph Leidy for study and description, and formed the basis of a short communication to the Philadelphia Academy of Natural Sciences, which was published late in the same year. In this paper Leidy briefly described *Saniwa ensidens*, the first recorded evidence of the presence of the family Varanidae in North America.

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[1] Proc. Acad. Nat. Sci. Philadelphia, vol. 8, p. 52.

In 1871 Prof. O. C. Marsh conducted an expedition for Yale University into the Eocene deposits of southeastern Wyoming in search of vertebrate fossils, and among other materials collected were the fragmentary remains of several lacertilian reptiles. These resulted in the establishment of the genus *Glyptosaurus* and the description of four new species, *G. sylvestris*, *G. anceps*, *G. nodosus*, and *G. ocellatus*, all based on fragmentary specimens which did not disclose their family relationships.

Owing to continued explorations of the Eocene of the Bridger Basin in southeastern Wyoming and of the Oligocene deposits in northeastern Colorado by Cope and Marsh, knowledge of the extinct lizards increased more rapidly in the two years following, 1872 and 1873, than in any similar period of their entire history in this country. No less than 10 genera and 26 species were established by Leidy, Cope, and Marsh, within this period.

In the 19 years following, not a single new form was described. A number of scattering papers dealing with the extinct Lacertilia appeared, largely reprints, although a few contained more extended observations on previously described forms.

In 1889 the late Mr. J. B. Hatcher discovered mammals in the Upper Cretaceous of Converse County (now Niobrara County), Wyo (See fig. 1.) A remarkable fauna resulted from four seasons' work (1889–1892), during which Hatcher and his assistants collected several thousand isolated teeth, jaws, and other bones of these diminutive mammals. Associated with these were the remains of lizards, but until recently no systematic attempt was ever made to isolate them. Professor Marsh described 18 new genera and 32 species of the mammals, but except for two forms, *Chamops segnis* and *Iguanavus teres*, described in 1892, no especial attention was given to the lizards.

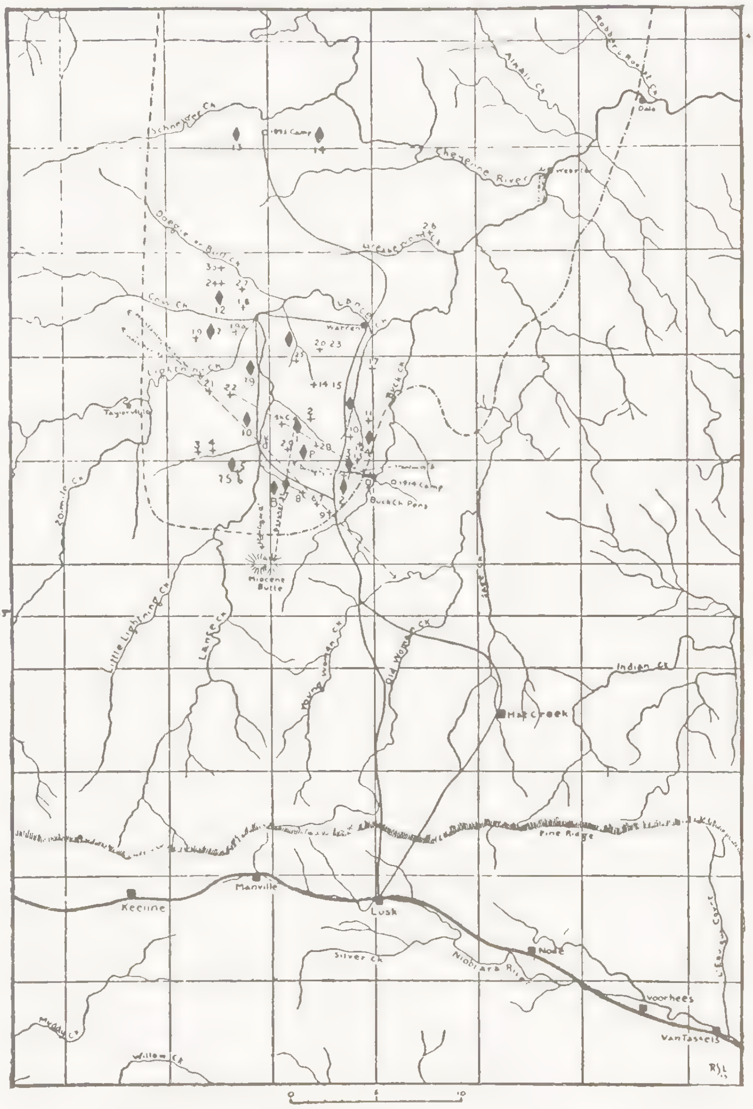

FIG. 1.—Map of Niobrara County, Wyoming. Diamonds indicate mammal and lizard localities; broken and dotted line, limits of Lance formation. (After Lull)

In the belief that the considerable amount of miscellaneous detrital materials remaining in the collections of the United States National Museum after the removal of the mammal jaws and teeth might yield important lizard specimens, a systematic and careful search was undertaken. This was rewarded by the recovery of specimens which show the existence in the Lance formation of a lizard fauna that in diversity of forms represented probably is not equaled elsewhere. They consist of jaws, both upper and lower, some containing teeth, an occasional vertebra, and other fragmental parts. No two bones can certainly be regarded as belonging to a single individual, as Hatcher's account of their scattered occurrence clearly shows. His description of this and of the methods used in collecting these diminutive fossil mammals applies equally well to the lizard specimens found with them. He thus described the method of field research.[2]

> The small mammals are pretty generally distributed but are never abundant, and on account of their small size are seen with difficulty. They will be most frequently found in what are locally known as "blow-outs" and are almost always associated with garpike scales and teeth, and teeth and bones of other fish, crocodiles, lizards, and small dinosaurs. These remains are frequently so abundant in "blow-outs" as to easily attract attention, and when such a place is found careful search will almost always be rewarded by the discovery of a few jaws and teeth of mammals. In such places the ant hills, which in this region are quite numerous, should be carefully inspected, as they will almost always yield a goodly number of mammal teeth. It is well to * * * sift the sand contained in these ant hills, thus freeing it of the finer materials and subjecting the coarser material remaining in the sieve to a thorough inspection for mammals. By this method the writer has frequently secured from 200 to 300 teeth and jaws from one ant hill. In localities where these ants have not yet established themselves, but where mammals are found to be fairly abundant, it is well to bring a few shovels full of sand with ants from other ant hills which are sure to be found in the vicinity, and plant them on the mammal locality. They will at once establish new colonies, and, if visited in succeeding years, will be found to have done excellent service in collecting mammal teeth and other small fossils, together with small gravels, all used in the construction of their future homes.

In 1893, Dr. George Baur announced the presence of amphisbaenoid lizards in the Oligocene deposits of South Dakota, when he briefly described *Rhineüra hatcherii* and *Hyporhina antiqua*. This discovery was of great interest as recording for the first time the presence of amphisbaenoid lizards in the fossil state.

In 1903 Mr. Earl Douglass, in charge of paleontological explorations for the Carnegie Museum, increased the known geographical and geological range of *Glyptosaurus* by the discovery of fragmentary remains in the Oligocene of Montana, and in 1907, Dr. F. B. Loomis still further extended their range by the discovery of *Glyptosaurus obtusidens* in the Wasatch of the Big Horn Basin in Wyoming.

In 1908 Mr. L. M. Lambe announced the presence of lacertilian remains in the Oligocene of the Cypress Hills, Saskatchewan, based on a collection made by him in this area in 1904. These were of interest as being from the most northerly point at which remains of Sauria had ever been found on this continent.

In 1908 Douglass described for the first time a nearly complete articulated skull of *Glyptosaurus montanus* thus contributing much to the knowledge of the cranial structure of this genus. In the same article were published for the first time illustrations of the extinct amphisbaenian *Rhineüra hatcherii* from the Oligocene of Nebraska, found by Mr. O. A. Peterson while in charge of a field expedition for the Carnegie Museum.

In 1919 Loomis described a supposed amphibian, *Ototriton solidus*, from the Wasatch of Wyoming; this, however, proves to be a member of the Amphisbaenidae.

The brief review given above sets forth the recorded growth of our knowledge of the North American Sauria. There was, however, especially during the past 25 years, a gradual accumulation of lacertilian remains in the various museums as a result of their collecting expeditions, particularly those sent to the Rocky Mountains and plains regions. Beyond listing these as "lizard remains," very little has been attempted toward their identification, and it is these accumulations, brought together to be studied as a unit with the types, that form the basis of the present work.

GEOLOGICAL DISTRIBUTION OF SAURIA IN NORTH AMERICA

Lizards have a great antiquity, beginning, as is known, with *Paliguana whitei* Broom from the Triassic of South Africa, the most ancient member of the suborder known. In North America no land lizard certainly identifiable as Sauria is known to have existed in deposits older than the Belly River formation of the Upper Cretaceous. This statement of course excludes the marine Mosasauria, which are not included in this study. It should be mentioned, however, that the Mosasauria have a wide distribution, but nowhere are their remains known outside of the marine and brackish water deposits of the Upper Cretaceous. In the United States representatives of this group occur along the Atlantic and Gulf borders, extending northward through the western plains region to the Canadian border. Their remains are recorded from the Benton, Niobrara, and Pierre formations of the western United States; from the Selma Chalk and Peedee formations of the Gulf region; and the Black Creek and Cretaceous greensand deposits of the Atlantic Coastal plain.

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[2] Amer. Nat., vol. 30, 1896, p. 119.

Palaeosaniwa canadensis, from the Belly River of Alberta, if correctly referred to the Varanidae, marks the earliest appearance of that family. Although based on scanty materials, these show a high degree of specialization indicating a long antecedent history or else a preceding period of accelerated development of which we now know nothing. *Cteniogenys antiquus,* from the Morrison formation, is a problematical genus doubtfully referred to the Lacertilia. It is possible that when better specimens are known it will be found to have its affinities with the Amphibia.

Passing upward to the Lance, there is found the most extensive and diversified lizard fauna known in North America if not in the world. While two of its members, *Peltosaurus*? *piger* and *Exostinus*? *lancensis,* have been referred to Oligocene genera representative of the Anguidae and Iguanidae, their reference as to both genus and family may as yet be considered uncertain. *Iguanavus* and *Chamops* are doubtfully regarded as pertaining to the Iguanidae, which, if correct, marks the first appearance of this family in the fossil record. The Varanidae is quite certainly represented by species of the genera *Parasaniwa* and *Palaeosaniwa.* No clue was obtained as to the family affinities of a considerable number of the newly described genera and species. In addition to these little known forms there is fragmentary evidence indicating the existence in the Lance of a number of undescribed forms, but it was considered unwise to describe them at this time on such scanty evidence.

On entering the Tertiary (Paleocene), the first undoubted member of the Anguidae is found represented by the genus *Peltosaurus*—specimens clearly identifiable as to genus but not specifically determinable. The Wasatch is marked by the first appearance of the Amphisbaenidae, represented by *Ototriton solidus* Loomis. The Wind River has so far furnished a single species of *Saniwa* and fragmentary specimens of *Glyptosaurus,* both genera being found in equivalent beds of the Huerfano. In the Bridger, lizard remains are numerous but there is no such diversity of forms as are found in the Lance. The Anguidae and Varanidae were especially numerous in species as well as individuals, and this period also marks the first appearance of the Chamaeleonidae in the two species *Tinosaurus stenodon* Marsh and *T. pristinus* (Leidy). The known species from the Bridger are about equally divided between horizons B and C. No lizard remains are known from the lower horizon A. Since, as Matthew has pointed out,[3] "the upper horizons C, D, and E, are found only in the southern part of the basin and the lower ones, A and B, only in the central and northern part," the recorded localities of all of the earlier described forms determine their level in the formation. Those labeled from Henry's Fork were regarded as horizon C or higher, and those from Grizzly Buttes, Hams Fork, etc., were regarded as from horizon B. The Uinta, so far as known, contains only species found also in the Bridger. The Varanidae made their last appearance in North America in the Oligocene.

The advent of the Oligocene shows a noticeable change in the lizard fauna by the introduction of many new genera, and especially important is the first occurrence of living genera such as *Heloderma* and *Rhineüra.* Although the Anguidae is still represented, all pertain to species distinct from those of the Eocene. It should be noted that two genera and one species are common to the middle and upper horizons of the Oligocene. The John Day of Oregon is said by Cope to contain lacertilian remains, but none was found in the many collections examined.

The Miocene, although containing members of the Ophidia, has not as yet produced any representatives of the Sauria.

In the Pliocene there are but two records, a single unidentifiable specimen from the Siesta formation of California and a fragmentary dentary from near Benson, Ariz. The latter is indistinguishable from the living *Crotaphytus,* which inhabits that area at the present time.

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[3] Mem. Amer. Mus. Nat. Hist., vol. 9, pt. 6, 1909, p. 297.

Some fragmentary remains from Long Island, Kans., may eventually be shown to belong to the Sauria.

From the Pleistocene there is recorded but a single identifiable genus, *Phrynosoma*, from the Conard Fissure, in Arkansas, although remains of Sauria are known from the Frankstown Cave in Pennsylvania.

In the table given below I have endeavored to present the geological distribution of extinct Sauria in North America. So far as possible the exact geological occurrence of each species is indicated, but the lack of original field data, especially in relation to collections in the early days of paleontological work, makes the allocation of a few species a little uncertain. Fortunately the collectors of recent years have exercised more care in the recording of geological levels and exact localities for their specimens, and these can be accurately assigned to their proper position in the geological column.

GEOGRAPHICAL DISTRIBUTION OF EXTINCT SAURIA IN NORTH AMERICA

In the accompanying map (fig. 2) are shown all of the important localities in North America where saurian remains have been found.

The occurrence of members of the Amphisbaenidae in Wyoming (11), South Dakota (7), and Nebraska (6), and of *Heloderma* in northeastern Colorado (13) is of interest as indicating dry-land conditions and a considerably milder climate in Oligocene times than those regions enjoy to-day. The living representatives of the Amphisbaenidae largely inhabit the tropical regions of America and Africa, one species coming as far north as Florida. *Heloderma* now has a northerly range into southern Utah. Likewise the presence of Anguidae (2) and Varanidae (1) in the Oligocene and Upper Cretaceous deposits of southern Alberta considerably extends the northern range of those families.

HISTORY OF THE CLASSIFICATION OF EXTINCT NORTH AMERICAN SAURIA

The first complete list of extinct North American lizards, compiled by Dr. O. P. Hay in his *Catalogue of fossil vertebrata of North America*,[4] includes all of the genera and species described up to the year 1902. This list is given below, according to his classification:

Suborder Sauria Macartney

Family Iguanidae:
- Iguanavus exilis Marsh.
  - teres Marsh.
- Chamops segnis Marsh.

Family Anguidae:
- Placosaurus, sp. indet.
- Glyptosaurus anceps Marsh.
  - brevidens Marsh.
  - nodosus Marsh.
  - ocellatus Marsh.
  - princeps Marsh.
  - rugosus Marsh.
  - sphenodon Marsh.
  - sylvestris Marsh.
- Xestops gracilis (Marsh).
  - lentus (Marsh).
  - microdus (Marsh).
  - minutus (Marsh).
  - vagans (Marsh).
- Saniwa ensidens Leidy.
  - major Leidy.
- Peltosaurus granulosus Cope.
- Exostinus serratus Cope.

Suborder Sauria Macartney—Continued

Family Varanidae:
- Thinosaurus agilis Marsh.
  - crassus Marsh.
  - grandis Marsh.
  - leptodus Marsh.
  - paucidens Marsh.
- Tinosaurus lepidus Marsh.
  - stenodon Marsh.

Family Amphisbaenidae:
- Rhineüra hatcherii Baur.
- Hyporhina antiqua Baur.
- Tylosteus ornatus Leidy.
- Aciprion formosum Cope.
- Diacium quinquepedale Cope.
- Cremastosaurus carinicollis Cope.
- Platyrhachis coloradoensis Cope.
  - rhambastes Cope.
  - unipedalis Cope.
- Naocephalus porrectus Cope.

Suborder Rhiptoglossi Wiegmann

Family Chamaeleonidae:
- Chamaeleo pristinus Leidy.

The above family allocation of the described genera was the result of a personal examination of the literature by Doctor Hay, and should not be confused with an actual handling of the fossils themselves. On the whole, these allocations have stood the test of this more critical

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[4] Bull. U. S. Geol. Surv., No 179, 1902, pp. 473–478.

Geological distribution of Sauria in North America

Era	Period	Division	Formation	Zone	Sauria
CENOZOIC	Pleistocene				Phrynosoma sp., Sauria [Frankstown Cave].
	Pliocene				Crotaphytus? sp., Sauria [Siesta formation].
	Miocene				No Sauria known.
	Oligocene	Upper	John Day		Lacertian (fide Cope).
		Middle	White River	Leptauchenia zone	Rhineüra hatcherii, Hyporhina antiqua, Peltosaurus abbotti, P. granulosus.
				Oreodon zone	Aciprion formosum, A. majus, Rhineüra hatcherii, Heloderma matthewi. Glyptosaurus giganteus, Peltosaurus granulosus, Exostinus serratus. Cremastosaurus carinicollis, Diacium quinquepedale.[1]
				Titanotherium zone	Rhineüra coloradoensis, Glyptosaurus tuberculatus. Glyptosaurus montanus, ?Saniwa sp. Cremastosaurus unipedalis, C. rhambastes.
		Lower			
	Eocene	Upper	Uinta		Saniwa paucidens, S. crassus, Glyptosaurus sp.
		Middle	Bridger	E	No Sauria known.
				D	No Sauria known.
				C	Glyptosaurus sphenodon, Xestops minutus, X. gracilis, ?X. lentus, ?X. microdus. Iguanavus exilis, Tinosaurus stenodon, Saniwa crassas, S. agilis.
				B	Saniwa ensidens, S. paucidens, S. grandis, Glyptosaurus sylvestris. G. princeps, G. rugosus, G. nodosus, Xestops vagans. Ototriton anceps, Tinosaurus pristinus,[1] Naocephalus porrectus.[1]
				A	No Sauria known.
			Wind River		Saniwa grandis, Glyptosaurus sp., Parasauromalus olseni.
		Lower	Wasatch		Ototriton solidus, Glyptosaurus obtusidens. Saniwa cf. ensidens, Melanosaurus maximus.
	Basal Eocene		Fort Union		Harpagosaurus excedens. Peltosaurus sp.
MESOZOIC	Cretaceous	Upper	Lance		Chamops segnis, C. denticulatus. Peltosaurus? piger. Palæosaniwa cf. canadensis. Parasaniwa wyomingensis, P. obtusus. Iguanavus teres. Lanceosaurus hatcheri, L. compressus. Megasaurus robustus. Odaxosaurus obliquus. Prionosaurus regularis. Alethesaurus quadratus. ?Exostinus lancensis. Harpagosaurus parvus. Habrosaurus dilatus.
			Fox Hills		No Sauria known.
			Bear Paw		Mosasauria
			Judith River (Belly River)		Paleosaniwa canadensis.
			Pierre:		
			Claggett		No Sauria known.
			Eagle		No Sauria known.
			Niobrara		Mosasauria.
			Benton		Mosasauria.
			Dakota		No Sauria known.
		Lower			No Sauria known.
	Jurassic		Morrison		Cteniogenys antiquus (reference to Sauria uncertain). Opisthias rarus (Rhyncocephalia).

Glyptosaurus sp. ?Peltosaurus	Cypress Hills, Canada.

Huerfano	Upper	Saniwa sp. Glyptosaurus hillsi. Glyptosaurus sp.
	Lower	Saniwa sp. Glyptosaurus cf. hillsi.

Torrejon	Machaeosaurus torrejonensis Peltosaurus sp.
Puerco	No Sauria known.

Eastern region	
New Jersey, Cretaceous.	Sauria undetermined.

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[1] Geological horizon not positively known.

30638°—28. (Face p. 6.) No. 1

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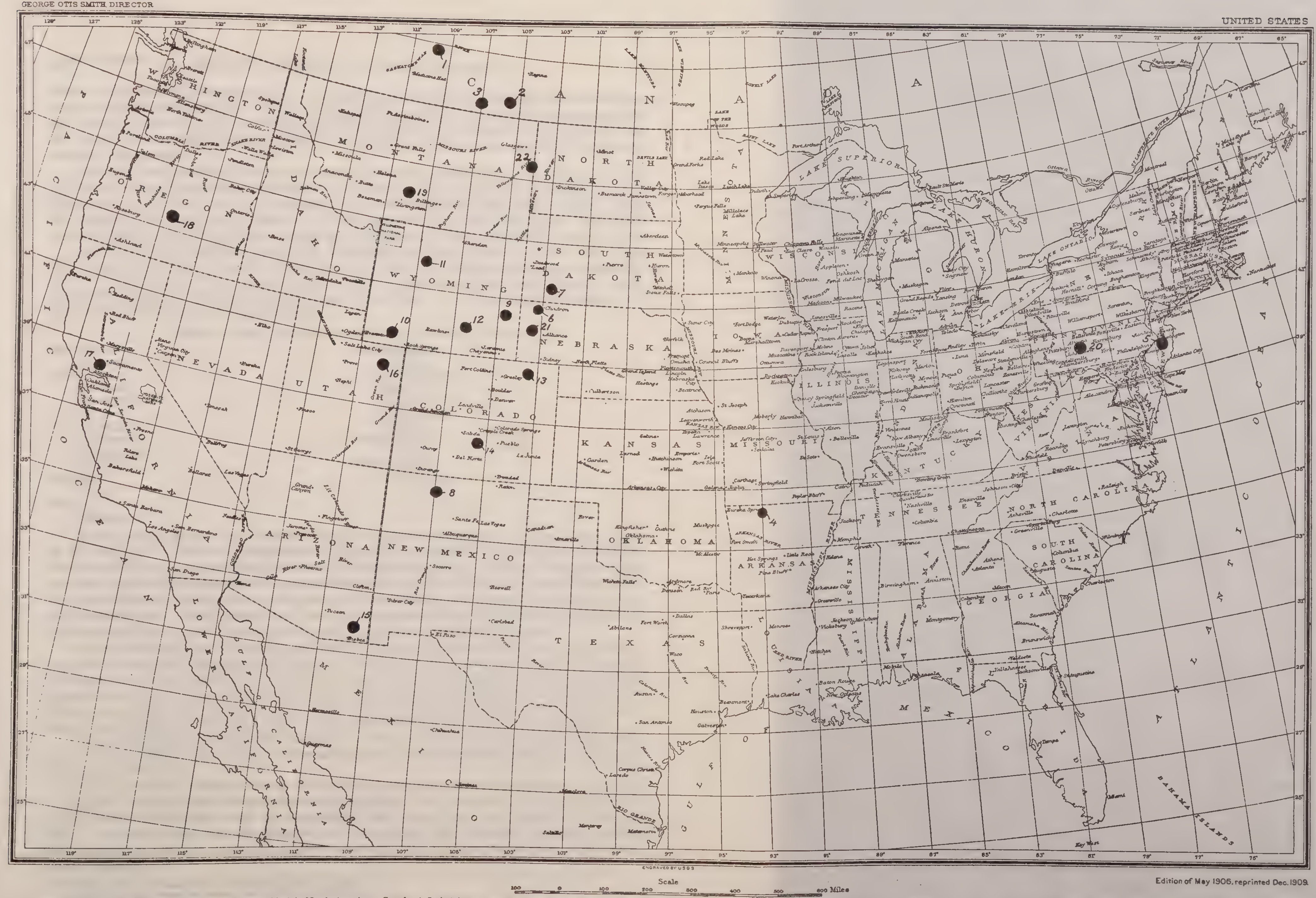

Edition of May 1906, reprinted Dec. 1909.

Fig. 2. Chief localities for fossil Sauria (exclusive of Mosasauridae) in North America. *Canada*: *1*. Saskatchewan and Red Deer Rivers, Alberta; Belly River, Upper Cretaceous. *2*. Cypress Hills, Saskatchewan; Oligocene. *3*. Rocky Creek, Saskatchewan; Lance. *United States*: *4*. Conard Fissure, Arkansas; Pleistocene. *5*. New Jersey; Upper Cretaceous. *6*. Sioux County, Nebraska; Oligocene. *7*. Washington County, South Dakota; Oligocene. *8*. San Juan County, New Mexico; Basal Eocene. *9*. Niobrara County, Wyoming; Lance, Upper Cretaceous. *10*. Bridger Basin, Wyoming; Bridger, Middle Eocene. *11*. Big Horn Basin, Wyoming; Washakie, Eocene. *12*. Como, Albany County, Wyoming; Morrison. *13*. Pawnee Buttes, Colorado; Oligocene. *14*. Huerfano Basin, Colorado; Huerfano, Eocene. *15*. Benson, Cochise County, Arizona; Pliocene. *16*. Uinta Basin, Utah; Eocene. *17*. California; Siesta, Pliocene. *18*. Christmas Lake, Oregon; Pleistocene. *19*. Montana; Fort Union, Basal Eocene. *20*. Frankstown Cave, Pa.; Pleistocene. *21*. Nebraska; Snake Creek beds, Pliocene. *22*. Richland County, Montana; Lance, Upper Cretaceous

30638°—28. (Face p. 6.) No. 2

study of the type and other materials. A few genera, as one might well expect, have been found to have other family affinities. It is quite apparent that the family Amphisbaenidae was used by Hay as a repository for all of those genera and species whose affinities were in doubt, with the result that this family has accumulated a heterogeneous group of genera, very few of which actually belong there.

In 1903 Douglass described the new genus and species *Helodermoides tuberculatus*;[5] in 1907 Loomis described *Glyptosaurus obtusidens*;[6] in 1908 Douglass added a second species in *G. montanus*;[7] and in 1919 Loomis [8] described the new genus and species *Ototriton solidus*, which was supposed to belong to the Amphibia; it is now referred to the Amphisbænidae. These four species comprise all of the additional forms up to the time of the beginning of the present study.

In 1908 Nopcsa [9] published a list of all of the genera of extinct lizards of the world. These are grouped under twelve families. Below is given a list of the American genera as classified by him. It will be noted that the genus *Tinosaurus* is omitted, and also that Nopcsa's family assignment of genera differs considerably from that of Hay. In several instances changes have been made which are without justification.

NOPCSA'S FAMILY CLASSIFICATION OF NORTH AMERICAN GENERA

- Iguanidae.
  - Iguanavus.
- Anguinidae.
  - Exostinus.
  - Peltosaurus.
  - Xestops.
- Helodermatidae.
  - Glyptosaurus.
  - Helodermoides.
  - Thinosaurus.
- Varanidae.
  - Saniva.
- Teiidae.
  - Chamops.
- Amphisbænidae.
  - Aciprion.
  - Cremastosaurus.
  - Diacium.
  - Hyporhina.
  - Platyrhachis.
  - Rhineüra.
- Cameleontidae.
  - Cameleo.
- Incertae sedis.
  - Naocephalus.

In the present paper I have followed Camp's classification as given in his excellent paper on the subject.[10] This is a correlation of previous investigations with results obtained by morphological and paleontological studies of the lacertilian group. I do not pretend to pass upon the merits of this classification as a whole—that should be left to the herpetologist—but his paleontological results, with few exceptions, I can heartily indorse and have adopted with slight modification. Such changes as I have made are largely due to the better understanding of the extinct forms brought about by the study of all known American material.

In the defining of families, genera, and species I have freely extracted from various authors, especially Camp and Boulenger, such parts of their characterizations as relate to the osseous structure, in order to make the definitions such as will meet the requirements of the paleontologist, who, with the rarest exception, never deals with any parts except the fossilized bones. Whenever possible the characters have been verified, though the limited amount of recent skeletal material at my command has not made this feature of the work at all exhaustive.

For paleontological purposes the definitions of genera must be used in a much wider sense than in recent zoology, since many of the allied genera are distinguished chiefly by characters not available in fossils.

The fragmentary nature of many of the type specimens renders it practically impossible to certainly determine their proper systematic position. In a number of instances where no clue to their relationships could be ascertained these forms have been grouped as incertae sedis. It is anticipated that the discovery of new material will sufficiently augment some of these types as to make it eventually possible to assign them to their proper place in the classificatory system.

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[5] Douglass, Earl, Ann. Carnegie Mus., vol. 2, 1903, pp. 160, 161, text figs. 4, 5.

[6] Loomis, F. B., Amer. Journ. Sci., 4th ser., vol. 23, 1907, pp. 363, 364, fig. 3.

[7] Douglass, Earl, Ann. Carnegie Mus., vol. 4, 1908, pp. 278-281, text figs. 1, 2.

[8] Loomis, F. B., Amer. Journ. Sci., vol. 47, 1919, pp. 217-219, text fig. 1.

[9] Nopcsa, F. B., Beitr. Pal. Geol. Oester.-Ung., vol. 21, 1908, p. 49.

[10] Camp, C. L., Classification of the Lizards: Bull. Amer. Mus. Nat. Hist., vol. 48, art. 11, pp. 289-481, 1923.

OUTLINE OF CLASSIFICATION ADOPTED

- **Suborder Sauria.**
  - Division Ascalabota.
    - Section Gekkota.
      - Family Ardeosauridae
      - Family Gekkonidae.
      - Family Uroplatidae.
    - Section Iguania.
      - Family Iguanidae.
      - Family Agamidae.
    - Section Rhiptoglossa.
      - Family Chamaeleontidae.
  - Division Autarchoglossa
    - Section Scincomorpha.
      - Superfamily Xantusioidea.
        - Family Xantusiidae.
      - Superfamily Scincoidea.
        - Family Scincidae.
        - Family Anelytropsidae.
        - Family Feyliniidae.
        - Family Dibamidae.
      - Superfamily Lacertoidea.
        - Family Gerrhosauridae.
        - Family Lacertidae.
        - Family Teiidae.
      - Superfamily Amphisbaenoidea.
        - Family Amphisbaenidae.

- Suborder Sauria—Continued.
  - Division Autarchoglossa—Continued.
    - Section Anguimorpha.
      - Family Euposauridae.
      - Subsection Platynota.
        - Superfamily Varanoidea.
          - Family Varanidae.
            - Subfamily Varaninae.
            - Subfamily Saniwinae.
          - Family Dolichosauridae.
          - Family Aigialosauridae.
        - Superfamily Mosasauroidea.
          - Family Mosasauridae.
          - Family Globidentidae.[11]
      - Subsection Diploglossa.
        - Superfamily Pygopodoidea.
          - Family Pygopodidae.
        - Superfamily Anguioidea.
          - Family Helodermatidae.
          - Family Anguidae.
          - Family Xenosauridae.
          - Family Anniellidae.
        - Superfamily Zonuroidea.
          - Family Zonuridae.
            - Subfamily Zonurinae.
            - Subfamily Chamaesaurinae.

Nopcsa considered the known extinct lizards of the world as pertaining to 12 families; Hay included all American forms in five families. Representatives of six families are now recognized in North America. Below is given a list of these with the allocated genera and species:

LIST SHOWING FAMILY ASSIGNMENTS OF GENERA AND SPECIES

- Family Iguanidae.
  - Iguanavus exilis Marsh.
    - teres Marsh.
  - Aciprion formosum Cope.
    - majus, new species.
  - Exostinus serratus Cope.
    - ? lancensis, new species.
  - Chamops segnis Marsh.
    - denticulatus, new species.
  - Parasauromalus olseni, new genus and species.
  - Phrynosoma sp.
  - Crotaphytus sp.
- Family Chamaeleonidae.
  - Tinosaurus stenodon Marsh.
    - pristinus (Leidy).
- Family Amphisbaenidae.
  - Rhineüra hatcherii Baur.
    - coloradoensis (Cope).
  - Ototriton solidus Loomis.
    - anceps (Marsh).
  - Hyporhina antiqua Baur.
- Family Varanidae.
  - Saniwa ensidens Leidy.
    - paucidens (Marsh).
    - grandis (Marsh).
    - crassa (Marsh).
    - agilis (Marsh).
- Family Varanidae—Continued.
  - Palæosaniwa canadensis, new genus and species.
  - Parasaniwa wyomingensis, new genus and species.
    - obtusa, new species.
- Family Helodermatidae.
  - Heloderma matthewi, new species.
- Family Anguidae.
  - Glyptosaurus sylvestris Marsh.
    - princeps Marsh.
    - rugosus Marsh.
    - nodosus Marsh.
    - sphenodon Marsh.
    - hillsi, new species.
    - obtusidens Loomis.
    - giganteus, new species.
    - montanus Douglass.
    - tuberculatus (Douglass).
  - Peltosaurus granulosus Cope.
    - abbotti, new species.
    - piger, new species.
  - Melanosaurus maximus, new genus and species.
  - Xestops vagans (Marsh).
    - ? gracilis (Marsh).
    - ? minutus (Marsh).
    - ? microdus (Marsh).
    - ? lentus (Marsh).
    - ? pawneensis, new species

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[11] Proposed by L. Dollo, Archives de Biologie, vol. 34, 1924, p. 1888.

SAURIA OF UNKNOWN FAMILY REFERENCE

Cremastosaurus carinicollis Cope.
  rhambastes Cope.
  unipedalis Cope.
Diacium quinquepedalis Cope.
Naocephalus porrectus Cope.
Harpagosaurus parvus, new genus and species.
  excedens, new species.
Megasaurus robustus, new genus and species.
Machaeosaurus torrejonensis, new genus and species.
Odaxosaurus obliquus, new genus and species.
Prionosaurus regularis, new genus and species.
Lanceosaurus hatcheri, new genus and species.
  compressus, new species.
Habrosaurus dilatus, new genus and species.
Alethesaurus quadratus, new genus and species.
Cteniogenys antiquus, new genus and species.

ALPHABETICAL LIST OF GENERA AND SPECIES WITH A SUMMARY OF DESCRIBED FORMS

For convenient reference there is given below a complete alphabetical list of all North American genera and species that have been described up to the year 1925. A reference is given to the original description of each, its present disposition in the synonymy, and location of the type specimen.

List of Genera and Species

Aciprion Cope, Synop. new Vertebrata from the Tertiary of Colorado, Washington, October, 1873, p. 17.
  formosum Cope, Idem. Type, No. 1609, American Museum of Natural History, New York.
Chamæleo Leidy, Proc. Acad. Nat. Sci. Philadelphia, December 12, 1872, p. 277. (=*Tinosaurus.*)
  pristinus Leidy, Idem. Type, No. 9134, Philadelphia Academy of Sciences. (=*Tinosaurus pristinus.*)
Chamops Marsh, Amer. Journ. Sci., 3d ser., vol. 43, 1892, p. 450.
  segnis Marsh, Idem. Type, No. 1036, Yale Museum.
Cremastosaurus Cope, Synop. new Vertebrata from Tertiary of Colorado, Washington, October, 1873, p. 18.
  carinicollis Cope, Idem. Type, No. 1604, American Museum of Natural History, New York.
Diacium Cope, Synop. new Vertebrata from Tertiary of Colorado, Washington, October, 1873, p. 17.
  quinquepedale Cope, Idem. Type, No. 1602, American Museum of Natural History, New York.
  unipedale Cope, Idem, p. 18. Type, No. 1605, American Museum of Natural History, New York.
Exostinus Cope, Synop. new Vertebrata from Tertiary of Colorado, Washington, October, 1873, p. 16.
  serratus Cope, Idem. Type, No. 1608, American Museum of Natural History, New York.
Glyptosaurus Marsh, Amer. Journ. Sci., 3d ser., vol. 1, 1871, p. 455.
  anceps Marsh, Idem, p. 458. Type, No. 520, Yale Museum. (=*Ototriton anceps.*)
  brevidens Marsh, Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 305. Type, No. 521, Yale Museum. (=*G. sylvestris* Marsh.)
  montanus Douglass, Ann. Carnegie Museum, vol. 4, 1906, pp. 278, 281. Type, No. 1050, Carnegie Museum.
  nodosus Marsh, Amer. Journ. Sci., 3d ser., vol. 1, 1871, p. 458. Type, No. 522, Yale Museum.
  obtusidens Loomis, Amer. Journ. Sci., 4th ser., vol. 23, 1907, pp. 363, 364. Type, No. 133, Amherst College.
  ocellatus Marsh, Amer. Journ. Sci., 3d ser., vol. 1, 1871, p. 458. (=*G. sylvestris* Marsh.)
  princeps Marsh, Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 302. Type, No. 524, Yale Museum.
  rugosus Marsh, Idem, p. 305. Type, No. 525, Yale Museum.
  sphenodon Marsh, Idem, p. 306. Type, No. 1051, Yale Museum.
  sylvestris Marsh, Amer. Journ. Sci., 3d ser., vol. 1, 1871, p. 456. Type, No. 526, Yale Museum.
Helodermoides Douglass, Ann. Carnegie Museum, vol. 2, 1903, p. 160. (=*Glyptosaurus.*)
  tuberculatus Douglass, Idem, pp. 160, 161. Type, No. 707, Carnegie Museum. (=*Glyptosaurus tuberculatus.*)
Hyporhina Baur, Amer. Nat., vol. 27, 1893, p. 998.
  antiqua Baur, Idem. Type, No. 11390, Princeton University.
Iguanavus Marsh, Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 309.
  exilis Marsh, Idem. Type, No. 1057, Yale Museum.
  teres Marsh, Amer. Journ. Sci., 3d ser., vol. 43, 1892, p. 451. Type, No. 530, Yale Museum.
Naocephalus Cope, Proc. Amer. Philos. Soc., vol. 12, 1872, p. 465.
  porrectus Cope, Idem. Type mislaid in American Museum of Natural History.
Ototriton Loomis, Amer. Journ. Sci., vol. 47, 1919, pp. 217–219.
  solidus Loomis, Idem. Type, No. 04–22 Amherst College.
Peltosaurus Cope, Paleont. Bull. No. 15, August 20, 1873, p. 5.
  granulosus Cope, Idem. Type, No. 1610, American Museum of Natural History.

Platyrhachis Cope, Synop. new Vertebrata from Tertiary of Colorado, Washington, October, 1873, p. 19. (=*Rhineura.*)
coloradoensis Cope, Idem. Type, No. 1607, American Museum of Natural History. (=*Rhineura coloradoensis.*)
rhambastes Cope, Idem. Type, No. 1606, American Museum of Natural History. (=*Cremastosaurus rhambastes.*)
Rhineüra Cope, Proc. Acad. Nat. Sci., Philadelphia, 1861, p. 75.
hatcherii Baur, Amer. Nat., vol. 27, 1893, p. 998. Type, No. 11389, Princeton University.
Saniwa Leidy, Proc. Acad. Nat. Sci. Phila., 1870, p. 124.
ensidens, Idem. Type, No. 2185, U. S. National Museum.
major Leidy, Ext. Vert. Fauna West Terr., vol. 1, 1873, p. 182. Type lost. (=*S. crassa.*)
Thinosaurus Marsh, Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 299. (=*Saniwa.*)
agilis Marsh, Idem, p. 302. Type, No. 609, Yale Museum. (=*Saniwa agilis.*)
crassus Marsh, Idem, p. 301. Type, No. 610, Yale Museum. (=*Saniwa crassa.*)
grandis Marsh, Idem, p. 301. Type, No. 611, Yale Museum. (=*Saniwa grandis.*)
leptodus Marsh, Idem, p. 300. Type, No. 612, Yale Museum. (=*Saniwa ensidens.*)
paucidens Marsh, Idem, p. 299. Type, temporarily lost, Yale Museum. (=*Saniwa paucidens.*)
Tinosaurus Marsh, Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 304.
lepidus Marsh, Idem, p. 308. Type, No. 1053, Yale Museum. (=*Tinosaurus stenodon.*)
stenodon Marsh, Idem, p. 304. Type, No. 615, Yale Museum.
Xestops (*Oreosaurus*) Cope, Synop. New Vert. from Tertiary of Colorado, Washington, October, 1873, p. 19.
gracilis (Marsh), Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 307. Type, No. 1055, Yale Museum.
lentus (Marsh), Idem. Type, No. 1052, Yale Museum.
microdus (Marsh), Idem, p. 308. Type, No. 1056, Yale Museum.
minutus (Marsh), Idem. Type, No. 1058, Yale Museum.
vagans (Marsh), Idem, p. 303. Type, No. 541, Yale Museum.

As shown in the preceding list, four genera are now regarded as synonyms, as follows:

Chamæleo=*Tinosaurus.*
Helodermoides=*Glyptosaurus.*
Platyrachis=*Rhineura.*
Thinosaurus=*Saniwa.*

The following species are regarded as synonyms:

Glyptosaurus brevidens and *G. ocellatus* =*G. sylvestris.*
Saniwa major=*S. crassa.*
Tinosaurus lepidus=*Tinosaurus stenodon.*

Below are listed the genera and species described in the present paper that are new to the Sauria. New genera are indicated by an asterisk.

Aciprion majus.
*Alethesaurus quadratus.
Chamops denticulatus.
*Cteniogenys antiquus.
Exostinus? lancensis.
Glyptosaurus giganteus.
hillsi.
*Habrosaurus dilatus.
*Harpagosaurus parvus.
excedens.
Heloderma matthewi.
*Lanceosaurus hatcheri.
*Lanceosaurus compressus.
*Machaeosaurus torrejonensis.
*Megasaurus robustus.
*Melanosaurus maximus.
*Odaxosaurus obliquus.
*Palæosaniwa canadensis.
*Parasaniwa wyomingensis.
obtusa.
*Parasauromalus olseni.
Peltosaurus abbotti.
Peltosaurus? piger.
*Prionosaurus regularis.
?Xestops pawneensis.

Thirteen genera and 25 species are added to the known North American Sauria.

In 1908 Nopcsa listed 57 genera and 112 species of fossil lizards, the whole constituting the known extinct lizard fauna of the world. Since one North American genus (*Tinosaurus*) and four species (*Glyptosaurus montanus* Douglass, *G. obtusidens* Loomis, *Thinosaurus grandis* and *T. paucidens* Marsh) were omitted from that list, and one genus and species, *Ototriton solidus* Loomis, has since been described, the total number would be 59 genera and 117 species. Of these totals, 18 genera and 43 species are North American in origin. Deducting the four genera and five species now regarded as synonyms, and adding the new forms here described, we have 27 genera and 63 species of fossil Lacertilia now recorded from North America, or a total of 68 genera and 137 species from the entire world. These figures are exclusive of the Mosasauridae, which, if included, would very much augment the totals.

DERIVATION OF THE SUBORDER SAURIA

The study of an extinct group of animals sooner or later brings up for consideration the question of their derivation. The origin of the lizards, as is the case with many other groups of extinct animals, can not yet be clearly explained. Suggested ancestral forms are not entirely lacking, but much additional knowledge is needed before their status as such can be fully confirmed.

By many authorities the opinion has long been held that the Squamata originated from the Rhynchocephalia, of which *Sphenodon* is the only surviving member, but as to how and when this divergence took place, no adequate explanation has been offered. Other paleontologists believe that the Squamata never passed through a rhynchocephalian stage, but that the single temporal arch and movable quadrate of the lizards were acquired through modifications brought about, not by a dropping out of the lower arch but by emargination from below of a broad, unfenestrated lateral arch. This view has been strongly championed by such able authorities as Baur, Williston, and Watson, and although the evidence is yet inconclusive, it seems to be the most plausible hypothesis yet advanced, especially in the light of the Permian *Araeoscelis*.

I have no intention of going exhaustively into the question of the ancestry of the Sauria, desiring only to call attention to a few American forms which have been suggested as possibly representing the group from which our fossil and modern lacertilians may have originated.

Although suggested relationships to the Squamata are found in the structure of the Triassic thalattosaurs,[12] they can not be considered more than an offshoot of the primitive reptilian stock from which the Squamata were derived. Furthermore, as pointed out by Merriam, their specialization to an aquatic life has removed them from the direct evolutionary line.

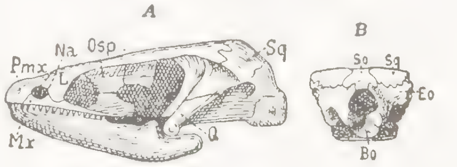

FIG. 3.—Skull of *Lysorophus tricarinatus* Cope. A, skull viewed from the left side; B, same from the back. Both about twice natural size. *Bo*, basioccipital; *Eo*, exoccipital; *L*, lachrymal; *Mx*, maxillary; *Na*, nasal opening; *Osp*, interorbital septum; *Pmx*, premaxillary; *Q*, quadrate; *So*, supraoccipital; *Sq*, squamosal. (After Broili)

The Triassic *Nectosaurus*, which for some time was regarded by Merriam[13] as being "primitive lacertilian," appears to have been properly referred by him to the Thalattosauria.

In 1908, after a restudy of the Permian genus *Lysorophus*, Broili [14] reached the conclusion that it is not an amphibian, as contended by Case,[15] but is reptilian and to be regarded as the oldest lacertilian. In the course of his discussion Broili points out some interesting resemblances between it and *Amphisbaena* in the elongated triangular shape and structure of the skull (see fig. 3); the strong inclination of the quadrate; the remarkably broad and flat form of the palate; the tripartate composition of the occipital condyle; and the absence of extremities.[16] He also reiterates his former conclusion that *Lysorophus* probably led a burrowing existence. While these similarities of skeletal structure might be construed as representing affinities between *Lysorophus* and *Amphisbaena*, it seems more probable that the likeness in structure may have been brought about by similar fossorial habits.

Huene,[17] after examination and study of many skulls, supports the contention of Case, Broom, and Williston that *Lysorophus* pertains to the Amphibia.

In view of this great disparity of opinion among eminent specialists, more convincing evidence of its lacertilian relationships will need to be produced before this genus can be included among the North American Sauria.

If *Paliguana*[18] from the Triassic is a true lacertilian, as some authorities seem to think, then it is to the Permian or an earlier geological period that we are obliged to look for the progenitors of the race. At this time there are no records of true Sauria from the Permian, but Williston found in the skeletal structure of the Permian *Araeoscelis* " little that would not confidently be expected in the primitive lizard." His masterly interpretation of the skeletal characteristics of *Araeoscelis* as showing relationships with the Squamata is given below:

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[12] Merriam, J. C., Memoirs California Acad. Sci., vol. 5, no. 1, 1905, p. 27.

[13] Op. cit., p. 37.

[14] Broili, F., Anatomischer Anzeiger, vol. 33, Jena, 1908, pp. 295–298.

[15] Case, E. C., Bull. Amer. Mus. Nat. Hist., vol. 24, 1908, pp. 531–533.

[16] Williston has shown that extremities were present. See Journ. Morphology, vol. 23, no. 4, 1912, pp. 664–666, by Marian Finney.

[17] Huene, F. von., Bull. Amer. Mus. Nat. Hist., vol. 32, 1913, pp. 373–375.

[18] Broom, R., Records Albany Mus., vol. 1, no. 1, 1903, pp. 1–3, pl. 1.

> *Squamata.*—I have no hesitation in saying that the skull and skeleton of *Araeoscelis* present distinctively primitive characters of the Squamata—to such an extent, indeed, that I believe the genus has a definite phylogenetic relationship with the order. In fact, as far as the skull is concerned, all that seems necessary to convert *Araeoscelis* into a primitive lizard is the erosion of the lower part of the squamosal bone until only a slender rod is left along the under side of the postorbital, and the development of streptostyly in the quadrate, which would necessarily ensue with the loss of the support of the squamosal. The quadrate is supported quite as in the lizards by the tabulare and paroccipital, in conjunction with the squamosal. The quadrate itself retains some of its primitive characters in its moderately expanded upper end, which, however, is much less in extent than in other known contemporary reptiles. It is visible in part from the side, and fully so from behind. The postorbital is peculiar and unlike that of other known reptiles in that it takes no part in the formation of the posterior border of the orbit. [A similar condition apparently exists in *Glyptosaurus*.] In conjunction with the postfrontal it is quite like that of the mosasaurs and lizards in its extension backward nearly to the tabulare. Among mosasaurs I have seen indications of a sutural division of the "postfronto-orbital," and I have little doubt that the bone is really composed of the two elements. If it be really only a single bone, it must be the postorbital, not the postfrontal. In the reduction of the lachrymal to a small or vestigial bone we have another pronounced lacertilian character, never before observed in the earliest reptiles.

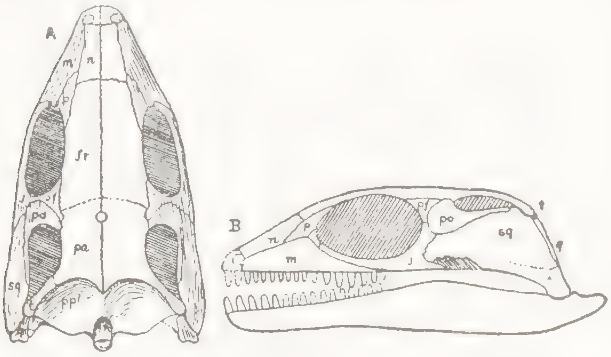

FIG. 4.—Skull of *Araeoscelis gracilis* Williston. A, skull from above; B, same from left side. Both about one and one-half times natural size. *fr*, frontal; *j*, jugal; *m*, maxillary; *n*, nasal; *p*, prefrontal; *pa*, parietal; *pf*, postfrontal; *po*, postorbital; *pp*, supraoccipital and paroccipital; *q*, quadrate; *sq*, squamosal; *t*, tabulare. (After Williston)

> Unfortunately I have been unable to determine all the details of the palate. Although teeth are not known on the vomers[19] of squamate reptiles [present in *Melanosaurus* and *Ophisaurus*] their presence in *Araeoscelis* is only what would be expected in a primitive lizard. Nor is the presence of teeth on the transverse bone (if it be distinct) a character to which any weight can be attached. Though no lizards have such teeth we may be sure that their ancestors had them.
>
> In the structure of the skeleton of *Araeoscelis* there is very little that would not confidently be expected in the primitive lizard. The ribs of the neck and lumbar region are single-headed in the strictest sense, not holocephalous, as in the cotylosaurs, and they articulate exclusively with the centrum. In the dorsal region they are dichocephalous, but the head and tubercle are close together, separated only by a short emargination. The head is articulated, unlike the condition in contemporary reptiles, high up on the side of the centrum near the front end, the tubercle to a short diapophysis on a level with and just back of the anterior zygapophyses. The fusion of these two articulations, or, what is more probable, a loss of the diapophysis, which actually occurs in the lumbar region, would make the rib attachment typically lacertilian. I am quite sure that the primitive lizards had dichocephalous or holocephalous ribs, that is, capitular and tubercular articulations. *Araeoscelis* offers a rational explanation of the way the very peculiar rib attachment of the Squamata arose.
>
> The pectoral girdle shows certain peculiarities not known among the Squamata, especially the separate articular facets in front of the glenoid facet, and the possible absence of the supracoracoid foramen. The distinction of the coracoid is not quite certain, though the dotted line of the figure represents what seems to be a real sutural division. I have urged that the posterior coracoid bone has been lost in all modern reptiles; that such a bone was present in the ancestral lizard is quite certain.
>
> In the anterior extremity the presence of a distinct ectepicondylar foramen, quite as in the lizards, is suggestive, at least, of genetic relationships; and there is also a suggestion that the entepicondylar foramen was obsolescent. The structure of the feet is unlike that of the contemporary reptiles in the elongated calcaneum and reduced astragalus. The pelvis is plate-like, without a decided pubo-ischiadic vacuity; but no other kind of a pelvis could be expected in the primitive lizards.

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[19] For some years I was inclined to accept the conclusions of Broom that the so-called vomers of most reptiles were not homologous with the vomer of mammals, which represented the parasphenoid; and to adopt the name he proposed for them, prevomers. The more recent studies of Gaupp, Fuchs, Versluys, and Terry throw grave doubt, to say the least, over these conclusions. I therefore return to the use of the term "vomer."

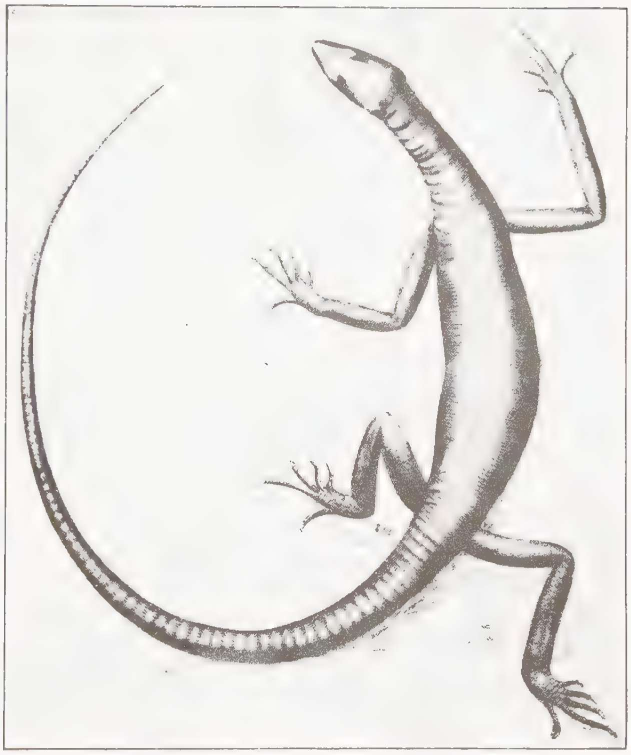

Fig. 5.—Restoration of Araeoscelis gracilis Williston. (After Williston)

> The elongation of the cervical vertebrae was clearly a specialization and not an ancestral character; but aside from this and the peculiar scapula, I can see nothing in the entire skeleton that might not have been confidently predicted in the ancestral lizard. It may be objected that the thecodont, or more properly protothecodont, teeth were an aberrant character; that the lizard ancestor must have had, like the living ones, acrodont or pleurodont teeth. On the contrary, I believe that the teeth primitively in the Squamata were protothecodont, which, by the loss of the parapet of bone on the inner side of the maxillae, and the anterior part of the coronoid, became pleurodont.

The meagerness of most of the known Sauria materials, and, especially on account of great gaps in the paleontological record, leaves so much to conjecture as to render a consideration of their evolutionary development of but little profit. Before material progress toward a solution of this question can be made, it will be necessary to determine more of those progressive structural changes which have taken place in the skull and skeleton of the Sauria throughout their recorded geological history, but at the present time the known materials, with but few exceptions, are so fragmentary and their structural details so obscure that their affinities can not be correctly éstimated, and any conclusion as to the evolutionary history of this suborder would be highly hypothetical. It is only when such information becomes available that it will be possible to recognize with assurance those primitive reptiles from which the Sauria were derived.

Camp,[20] after an exhaustive study of the paleotelic characters of the living Sauria, with some recourse to the extinct forms, in the course of which no less than 34 morphological features were considered, reached the conclusion that an ancestral form would have a fair proportion of the following characters:

> Vertebrae with centra cylindrical, not tapering, biconcave, and with thin, half ring-shaped intercentra.
> Teeth thecodont or pleurothecodont.
> Postfronto-squamosal arch short and massive. Postfrontal and postorbital present.
> Postorbital arch (jugal) broad, short, and erect. Skull elevated.
> Two dorsal temporal elements adjoining the quadrate.
> Median bones of skull roof not united.
> Teeth present on the pterygoid, palatine, and vomerine bones.
> A parasternum.
> A proatlas (?).
> An os intermedium.
> A pineal foramen.
> Pterygoids separated on the mid line.
> Ribs slightly double-headed. The third cervical with ribs.
> Lachrymal exposed externally as part of lower anterior border of orbit.
> Scapula narrow at base.
> Coracoids platelike and shallowly emarginate anteriorly.
> Clavicle broadened toward the mid line.
> Interclavicle a subrhombic plate.
> An epipterygoid.
> Osteoderms, if present, compound or diffuse.

My study of American fossil Sauria tends, in a few instances to confirm some of the points made by Camp, and attention should be called to the fact that the Permian *Araeoscelis* fulfills many of the ancestral requirements laid down by him; but before these suggestions can be considered as established facts, much additional confirmatory evidence must be forthcoming. It is in those annectent forms to be discovered in the Triassic, Jurassic, and Lower Cretaceous that we may look forward to with the greatest expectation to supply this much desired information.

SYSTEMATIC DESCRIPTION OF GENERA AND SPECIES

In the descriptions to follow, all genera and species of extinct North American lacertilian lizards are included. Since very few of these have been figured, all of the typical specimens, regardless of their final disposition in the synonymy, are fully illustrated. The original descriptions being comparatively short, are quoted in their entirety, so that all information leading up to the designation and assignment of the species is available to future students without the necessity of searching the literature for this preliminary information.

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[20] Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, pp. 337–421.

The complete bibliography of all species is given; the present location of each type specimen and its catalogue number; a list of the parts constituting the type; and the type locality and horizon with, if known, the name of the collector and date when collected.

While the distinctive characters of genera and species must necessarily be based on the original types, no opportunity has been neglected to further elucidate these characters by the description of any additional material that may have come to light. Care is taken to clearly distinguish between this and the original type material, and all specimens are definitely located by their catalogue numbers and a reference to the museum or organization to which they belong.

Class REPTILIA

Subclass DIAPSIDA

Order SQUAMATA

(Snakes and Lizards)

Squamata, Oppel, Ordn. Rep., 1811, p. 14.

Body, elongate, covered with corneous, or more rarely, with dermal scales or scutes. Quadrate movably attached to the skull, the lower temporal arcade always, and upper temporal arcade frequently wanting. Palatal vacuities large, pterygoids not in contact with vomer; external nares separated; teeth acrodont, subthecodont, or pleurodont. Vertebrae well ossified, usually procoelous, rarely amphicoelous; sacral vertebrae not more than two in number; postcervical intercentra wanting; abdominal ribs or parasternum often present; dorsal ribs single headed. Limbs adapted for ambulation or natation, absent in nearly all Serpentes and a few Sauria.

Three principal suborders, Sauria, Pythonomorpha, and Serpentes have usually been classed under the Squamata, but, following Camp, the Mosasauroidea (Pythonomorpha), an extinct group, is here included as a superfamily in the suborder Sauria.

Suborder SAURIA

(Lizards)

Sauria, MacCartney, in Ross's Transl. Cuvier's Lect. Comp. Anat., vol. 1, tab. 3, 1802.

Brain case never completely bony anteriorly; rami of lower jaw usually united by suture; usually ectepicondylar, never an entepicondylar foramen; pectoral girdle usually present; articular and prearticular always fused; quadrate streptostylic; usually two dorsal temporal elements articulating with the quadrate.

Camp, in the latest classification of the suborder Sauria, divides it into two divisions, the Ascalabota and the Autarchoglossa. Since these divisions are characterized entirely on the scales and soft anatomy, they are useless to the needs of paleontology and need no further mention here.

Division Ascalabota

Ascalabota, Merrem, *Tentamen Syst. Amphib.*, 1820, p. 9.

Section IGUANIA

Iguania, Latreille, *Fam. Nat. du Règne Animal*, 1825, p. 95.

Vertebrae always procoelous with large condyles and no intercentra; centra short, conical; skull arches complete; six cervical vertebrae.

Family IGUANIDAE

Teeth are usually subequal in size and if, as is usually the case, the lateral ones differ from the front ones, the change is gradual. In all genera save *Amblyrhynchus*, *Conolophus*, and *Phymaturus* the anterior teeth are conical; the lateral ones are also sometimes simply conical or with obtuse crowns, but more frequently compressed and tricuspid. In *Iguana* and *Meto-*

poceros the crowns are finely denticulated on the side. In the above-named genera all of the teeth are deeply trilobate, or *fleur-de-lis* shaped. The shafts of the teeth are constantly long and cylindrical, and hollowed out at the base. Dentition usually pleurodont. Pterygoid teeth are present in many species. *Chamaeleolis* is one of the few lizards in which teeth are inserted on the palatine bones. The skull does not differ in any important point from that of the Agamidae. However, dermal cranial ossifications, as, for instance, the hornlike tubercles of *Phrynosoma*, may be present. Premaxillae united. Cope furnishes the following characters of the mandible:

> Splenial well developed; Meckelian groove mostly closed, angular little developed on inner, much on outer side of ramus; coronoid produced anteriorly [except in *Crotaphytus* and *Sceloporus*] not posteriorly, on outer face of ramus.

The clavicle is slender, nondilated proximally, except in the genera *Basiliscus* and *Laemanctus* which have it loop-shaped. Intercalvicle T or anchor shaped except in *Phrynosoma*, in which the longitudinal limb is absent. Sternum is frequently perforated by a fontanelle. A more or less complete system of ossified or tendinous abdominal ribs is developed in many genera. Vertebral centra usually short and tapering.

The living members of the Iguanidae are almost entirely American, the exceptions being three genera, *Hoplurus* and *Chalarodon* in Madagascar, and *Brachylophus* in the Fiji Islands. Gadow states that there are about 300 different species grouped into about 50 genera, representing arboreal, terrestrial, burrowing, and even one semiaquatic species.

Most of the Iguanidae are insectivorous, but some, as the *Iguana*, *Amblyrhynchus*, and *Basiliscus*, are herbivorous. Evidence showing the antiquity of the family is not entirely lacking, as *Paliguana* and *Agama galliae* of Filhol, from the Upper Eocene (Quercy) of France, the Lance *Parasauromalus*, and *Aciprion* and *Exostinus* of Cope are quite certainly properly referred. The North American genus *Iguanavus* is problematical. Camp regards *Chamops* from the Lance as close to what would be expected in a stem form. The two recent genera *Phrynosoma* and *Crotaphytus* are found in Pleistocene and Pliocene deposits, respectively, of North America. Although outside of the scope of this paper, mention should be made of the extinct species *Cyclura mattea* Miller from the "kitchen middens" on the island of St. Thomas and *Cyclura portoricensis* Barbour from the floor of a cave in Porto Rico.

The geological distribution of the North American forms here included in the family Iguanidae is graphically shown in the accompanying table.

Geologic distribution of Iguanidae

Period		Formation		Species
Pleistocene				*Phrynosoma* sp.
Pliocene				*Crotaphytus*? sp.
Oligocene		White River	Oreodon zone	*Exostinus serratus.* *Aciprion formosum.* *Aciprion majus.*
			Titanotherium zone	
Eocene	Upper	Uinta		
	Middle	Bridger	C	*Iguanavus exilis.*
			B	
			A	
		Wind River		*Parasauromalus olseni.*
	Lower	Wasatch		
Basal Eocene				No members of the family known.
Upper Cretaceous		Lance		*Chamops segnis.* *C. denticulatus.* *Iguanavus teres.* *Exostinus? lancensis.*

Genus Iguanavus Marsh

Iguanavus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 309.

Genotype: Iguanavus exilis Marsh.

A little known genus established by Marsh on a single caudal vertebra from the Bridger, Middle Eocene, of Wyoming. Marsh (1872), Boulenger (1890), Hay (1902), and Nopcsa (1908) have all regarded this genus as belonging in the family Iguanidae. Camp (1923) considers the assignment problematical.

Two species have been described, *Iguanavus exilis* Marsh, from the Bridger formation, Eocene, and *I. teres* Marsh, from the Lance, Upper Cretaceous.

Iguanavus exilis Marsh

(Pl. 2, fig. 2)

Iguanavus exilis Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 309.—King, C., U. S. Geol. Expl. 40th Par., 1878, p. 405—Hay, O.P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 474—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.—Ung., vol. 21, 1908, p. 41.

Type specimen.—Yale University Museum, catalogue No. 1057. Consists of an anterior caudal vertebra. Collected by O. C. Marsh, September 21, 1871.

Type locality.—Near Henry's Fork, Uinta County, Wyo.

Horizon.—Horizon C or higher, Bridger formation, Middle Eocene.

Original description.—A new and interesting genus of extinct lizards, very different from those already described, may be predicated upon a number of vertebrae, and a few other isolated specimens which were brought to light during our explorations last year in the Eocene of Wyoming. The caudal vertebrae present are slender, and much elongated. The articular ball is but little depressed, only slightly inclined, and very convex. The chevrons are attached at the posterior end of the centrum, as in the Iguanas, to which the present species appears to be clearly related. The centra of the caudals, however, are less compressed than in that genus, and also want the unossified transverse septum. The vertebrae appear to have had only a rudimentary zygosphenal articulation. The specimens that can now be placed in this species belonged to animals about two feet in length.

Measurements

	Mm.
Length of twelfth caudal vertebra on the lower surface	7. 0
Transverse diameter of articular cup	2. 2
Vertical diameter	1. 8
Transverse diameter of articular ball	2. 0

In the above description Marsh mentions "a number of vertebrae and a few other isolated specimens," but his description and measurements apply only to a single caudal vertebra found with the type material. In the small glass vial in which these specimens were received, in addition to the single caudal mentioned above, were the following bones: Fragment of a small dentary with one complete tooth and basal portions of four others, a jaw that can be provisionally referred to *Xestops minutus;* anterior half of a caudal vertebra clearly referable to *X. lentus;* a crown of a low, elliptical shaped tooth that is questionably lacertilian; fragments of two vertebrae that may be regarded as indeterminate; anterior half of a dorsal vertebra and the greater portion of two other dorsal vertebrae. These last mentioned belong to a different kind of animal than those previously noted, but neither, because of their very small size, could be regarded as belonging to an animal of the dimensions indicated by the described caudal.

In view of the above facts, I now select the caudal vertebra as the type of the present genus and species, and since no good reason exists for considering any of the associated bones as belonging to this form, they may be dismissed from further discussion in that connection. That Professor Marsh was cognizant of this doubtful association is indicated by a slip of paper found with the "cotypes" on which he had made the following notation: "2 jaws both new or *O. minutus*, vert. = new Com. Iguana." In the light of this, some of the statements in the original description are difficult of understanding.

At best the caudal vertebra is a poor if not inadequate type (see pl. 2, fig. 2), but since it is the only caudal in the entire assemblage of Eocene lizard remains at my disposal which shows the chevron attachments to be at the posterior end, intercentral, it appears best for the present, at least, to continue the use of this genus and species. The discovery of more perfect material may show it to be synonymous with other forms from the Bridger established on jaws.

The type vertebra is elongate and probably from the anterior half of the tail. It certainly is more posterior than the twelfth, though that is the position given it by Marsh in the table of measurements. There is a vestige of a transverse process, and in *Iguana* well developed transverse processes comparable to the broken process on the fossil continue back as far as the thirteenth vertebra. The articular ball, viewed from the back, is oval, only slightly inclined, and very convex. The cup looks forward and slightly downward. The chevrons, as Marsh has pointed out, are attached at the posterior end of the centrum as in the living *Iguana*. The ventral surface is traversed longitudinally by a shallow groove. There is no evidence of a transverse septum such as is found in the caudals of the living *Iguana*.

The clear relationship to the living *Iguana* I regard as somewhat problematical. Tentatively, however, I shall retain this genus and species in the family Iguanidae because of the intercentral articulation of the chevrons, though aware that they have a similar articulation in the Agamidae, Lacertidae, most Scincidae, and Chamaeleonidae. It is also suggested that this caudal may eventually be found to pertain to *Tinosaurus* from the same geological horizon, which is quite certainly an agamid or a chamaeleontid.

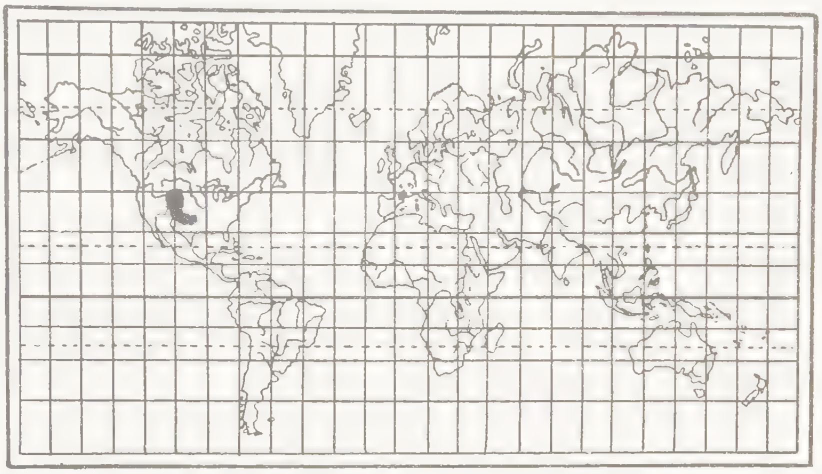

FIG. 6.—Map showing distribution of extinct Iguanidae

IGUANAVUS TERES Marsh

(Pl. 2, fig. 1)

Iguanavus teres Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 43, 1892, p. 451—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 474.—Bowen, C. F., Prof. Paper U. S. Geol. Surv., No. 90–I, 1915, pp. 128, 129.—Nopcsa, Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 41.

Iguanavus, Gilmore, C. W., Bull. 38, Geol. Surv. Canada, 1924, p. 27.

Type specimen.—Yale University Museum, catalogue No. 530. Consists of a single dorsal vertebra. Collected by J. B. Hatcher, 1889.

Type locality.—Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

Original description.—Another Lacertilian, much smaller than the above [*Chamops segnis*] left its remains in the same horizon. The specimens best preserved are vertebrae, which agree in general form of the centra with those just described, but possess the zygosphene articulation. They are about the size of the Ophidian vertebra above described [*Coniophis precedens*] but may be readily distinguished by the oblique and transversely expanded articular faces, and by the smooth under surface of the centrum. The type specimens are all from the Laramie of Wyoming.

Although Marsh mentions having vertebrae, I fail to find in the Yale collection more than the single vertebra labeled as the type. This is not as perfectly preserved as one might wish and many of the details are obscure due to the abrasion of its surfaces. It has the zygosphene articulation, but the zygopophyses both anterior and posterior are missing. The top of the neural arch is broadly convex transversely and concave longitudinally, and without neural spine. The articular condyle of the centrum, although somewhat worn, appears to look directly backward; the cup is slightly wider than high. The centrum is evenly rounded from side to side, and shallowly concave from end to end.

Measurements

	Mm.
Greatest length of centrum as preserved	3. 8
Greatest height of vertebra at center	3. 5
Greatest width of cup	2. 4
Greatest width of ball	2. 0

Marsh did not express an opinion as to the affinities of this species, though by its reference to *Iguanavus* it may be inferred that he regarded the relationship to be with the Iguanidae, probably because of the presence of a zygosphenal articulation of the vertebra. Whether or not his determination is correct, the fact remains that the fragmentary nature of the type is such as to preclude an adequate description, and for the present I shall consider it as being of uncertain reference.

A specimen in the paleontological collection of the Geological Survey of Canada (No. 2912), consisting of a perfectly preserved vertebra from the median caudal region, so closely resembles the type of *Iguanavus exilis* that I had little hesitancy in referring it to that genus.[a] This specimen was collected by Mr. C. M. Sternberg in 1921 from the Lance formation on Rocky Creek, Saskatchewan, Sec. 12, T. 1, R. 5, west of the third meridian. The caudal is more elongate than the type specimen of *Iguanavus exilis* and with a more reduced vestigial transverse process, both features indicating a more posterior position in the tail than that of the type of that species. The spinous process is very short, sharply pointed, and much inclined backward, in these features comparable with number 30 or 31 in the caudal series of the living *Iguana*. That it occupied a more advanced position in the tail is indicated by the vestigial transverse process and by the median longitudinal groove on the lower surface of the centrum.

The principal features of this specimen are well shown in Figure 1, Plate 2. The chevron attachment is intercentral, but there is no indication of a transverse septum. Its chief interest lies in the fact that it apparently demonstrates the presence of the genus *Iguanavus* in the Lance formation, for although Marsh founded the species *I. teres* on a Lance specimen, the type is a single dorsal vertebra and consequently the correctness of his generic assignment has never been verified. Now, however, the discovery of the specimen under discussion apparently indicates the presence of the genus *Iguanavus* in the Upper Cretaceous. Tentatively I shall refer this specimen to the Lance species *I. teres*.

Genus ACIPRION Cope

Aciprion Cope, E. D., Synopsis of new Vertebrata from the Tertiary of Colorado, Washington, October, 1873, p. 17.

Genotype.—*Aciprion formosum* Cope.

Characters.—Teeth pleurodont; tricuspid; anterior teeth simple; 20 maxillary and 25 dentary teeth, subequal in size. Dentary slightly longer than postdentary part of ramus; coronoid without anterior extension on the external face. Vertebrae unknown.

Neither in the original nor in subsequent descriptions did Cope state definitely what he considered to be the affinities of this genus. One might infer, however, that he regarded it as close to the Teiidae from the fact that he compared it with the "Cnemidophori." Zittel[21] regarded the genus as *incertae sedis*, Hay[22] included it without comment in the Amphisbaenidae, and Nopcsa,[23] though protesting, followed him in that assignment.

Fully realizing that the information is inadequate, I assign this genus to the family Iguanidae. That its closest affinities lie in that family appears to be indicated by the many resemblances in the dentition and the structure of the lower jaw to the extant genus *Crotaphytus*.

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[a] Gilmore, C. W., Bull. 38, Geol. Surv. Canada, 1924, p. 27.

[21] Handbuch der Paleontologie, vol. 3, 1890, p. 610.

[22] Bull. U. S. Geol. Surv., No. 179, 1902, p. 477.

[23] Beitr. Pal. Mud. Geol. Oester.-Ung., vol. 21, 1908, p. 36.

They have the following structural features in common: Coronoid without extension on external face; dentary extending to the line of the posterior border of the coronoid above; an inner horizontal hooklike process that extends inward opposite the cotylus; surangular and articular partially fused; teeth pleurodont, tricuspid, lateral cusps reduced; anterior teeth simple, subequal.

Aciprion differs from *Crotaphytus* in having the dentary considerably longer than the postdentary portion; by the greater number and more closely crowded teeth of *Aciprion* which have the crowns projecting much higher above the alveolar borders.

Aciprion now contains the two species *A. formosum* Cope and *A. majus* Gilmore. Both are from the Oligocene of Colorado.

Key to species

Ten and one-half teeth of dentary occupy a space of 5 mm	*A. formosum.*
Nine teeth of dentary occupy a space of 5 mm	*A. majus.*

ACIPRION FORMOSUM Cope

(Pl. 20, figs. 10, 10a)

Aciprion formosum Cope, E. D., Synop. new Vert. from the Tertiary of Colorado, Washington, October, 1873, p. 17; Ann. Rep. Geol. and Geogr. Surv. Terr., for 1873, 1874, p. 514; Rep. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 776, pl. 60, fig. 15.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 477.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 36.—O'Harra, C. C., Bull. South Dakota School of Mines, No. 9, 1910, p. 121.

Type specimen.—American Museum of Natural History, catalogue No. 1609. Consists of a dentary bone with seven perfect teeth. Collected by E. D. Cope in 1873.

Type locality.—Cedar Creek, Logan County, Colo.

Horizon.—Oreodon beds, White River formation, Oligocene.

Original description—Char. gen.—Represented by a dentary bone with nearly all of the teeth remaining. A groove, apparently the Meckelian, extends along the inferior border of the distal half of the bone. The teeth are truly pleurodont, closely placed, and cylindric, with compressed crowns. The latter supports a large median and two small lateral cusps, three in all.

Char. specif.—The crowns project well above the alveolar border. External face of dentary smooth, with rather distant foramina. Ten and a half teeth in M. 0.0050.

Measurements

	M.
Depth of dentary at middle	0. 0022
Length of a median tooth	. 0018
Elevation of same above alveolus	. 0010 [9 mm.]

This species is about the size of our *Cnemidophori*. From all the genera of this group, *Aciprion* differs in the uniform character of the teeth in the front of the series so far as preserved.

The above brief description covers all of the important features of the fragmentary type specimen, of which both articular ends of the dentary are missing. (See pl. 20, fig. 10.) The last distinction, however, no longer holds, as, in a second specimen, the type of *A. majus* (No. 10,015, Princeton Museum), the anterior lateral teeth are simple as in *Cnemidophorus*. *A. formosum* may be distinguished from *A. majus* by its smaller size, shorter tooth crowns above alveolar border of jaw, and better defined accessory denticles of the teeth.

REFERRED SPECIMEN

No. 10,962, United States National Museum. A fragmentary portion of a right maxillary bearing four posterior teeth. Oligocene, Hat Creek Basin, Sioux County, Nebr. Collected by J. B. Hatcher, 1888. This specimen is referred to the present species with some doubt since certain features observed in the sculpture of the tooth crowns suggest that it may represent an undescribed species, but on account of its fragmentary nature, I hesitate to name it. The tooth crowns are relatively low, tricuspid, but having the lateral denticles distinctly set off from the median cusp by pronounced vertical grooves that on the inner side extend well down on the crown. The median denticle is relatively broad, with an obtuse apex as contrasted with the acute apices in the two described species.

ACIPRION MAJUS, new species

(Pl. 20, fig. 11)

Type specimen.—Princeton University Museum, catalogue No. 10,015. Consists of a nearly complete articulated left maxillary and ramus, portion of the quadrate, and fragment of the jugal. Collected by the Princeton scientific expedition of 1882.

Type locality.—Chalk Bluffs, Logan County, Colo.

Horizon.—Oreodon beds?, White River formation, Oligocene.

In the report of the United States Geological Survey of the Territories, volume 3, 1884, page 777, Cope observes: "A jaw fragment probably represents a second species of this genus [*Aciprion*]. A well-preserved lower jaw of the *Aciprion formosum* was obtained in Dakota by the Princeton expedition of 1882."

The "jaw fragment" has not come into my hands. There is, however, in the Princeton collection a well-preserved lower jaw and maxilla of the left side (see fig. 11, pl. 20) labeled No. 10,015, Princeton Museum, Chalk Bluffs, Colo., and collected by the Princeton scientific expedition of 1882. This may be the specimen to which Cope refers and mistakenly records as coming from Dakota. It agrees very closely with the type of *Aciprion formosum* so far as comparisons can be made, and is regarded as pertaining to that genus, although differences are observed which appear to indicate its specific distinctness. Since it contributes considerably to our understanding of the anatomy of this genus, it will be described in detail.

The complete tooth series of the dentary consists of 25 closely placed, cylindrical teeth; the complete maxillary series of 20. Upper and lower teeth indistinguishable. The teeth project well above and below their respective alveolar borders. They have transversely compressed crowns, bearing three cusps, a large median with a small cusp both in front and back. These cusps are most prominently developed on the posterior half of both upper and lower series. Approaching the front the teeth gradually diminish in size and the lateral cusps become smaller and smaller, finally disappearing altogether on the first two or three teeth of the dentary and on the first tooth of the maxillary which has a simple, pointed crown.

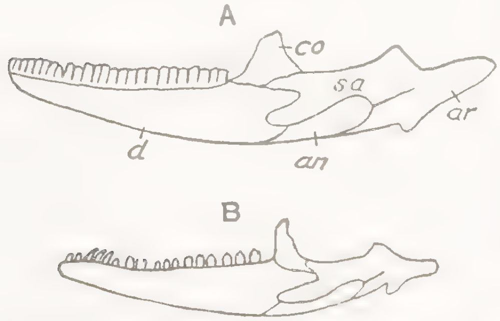

FIG. 7.—Comparative diagrammatic outlines of left rami of (A) *Aciprion majus* Gilmore (type, No. 10015, Princeton Museum) and (B) *Crotaphytus collaris* (Say) (No. 029187, U. S. Nat. Mus.). Both about twice natural size. Left lateral view. *an*, angular; *ar*, articular; *co*, coronoid; *d*, dentary; *sa*, surangular

Maxillary.—A fragment is missing from the median upper border of the maxillary which prevents giving its full outline. It appears to be relatively low, the posterior extremity being extended at a low angle and apparently extensively overlapped by the jugal, of which a fragment is lying in position as shown in Figure 11, Plate 20. In front the maxilla widens out into a horizontal plate that contributes to the formation of the floor of the external nares. The union with the premaxillary is wide and nearly straight transversely, when viewed from above, but below it overlaps the premaxillary by a beveled surface. There is the usual row of dental foramina.

Quadrate.—The quadrate bone of the left side has been preserved in situ. (See fig. 11, pl. 20.) It stands perpendicular, is relatively long and slender with an expanded upper extremity. The external conch is missing. The quadrate has a greatest length of 6 millimeters.

Lower jaw.—The left ramus is almost perfectly preserved but can only be studied from a lateral and ventral view since it is attached to a small block of matrix from which it was deemed inexpedient to remove it for fear of doing the specimen permanent injury. The center of the coronoid marks about the center of the ramus. Laterally the dentary extends posterior to the line of the posterior border of the coronoid above and apparently to the anterior border below. (See fig. 7A.) This overlapping portion of the dentary has scaled off but its extent posteriorly can be quite surely determined by the slight depressions in the surangular and angular.

Coronoid as in *Crotaphytus*, not horizontally produced on the external face of the ramus. Articular and surangular partially united; splenial moderately elongated; angle short, horizontal with short, hooked internal process; angular relatively small, the posterior half showing strongly from an external view. (See fig. 7A.)

Aciprion majus is to be distinguished from the other species of the genus by its larger size, relatively longer tooth crowns above the parapet of the jaw, and a less prominent development of the accessory denticles.

Measurements

	Mm.
Greatest length left ramus	27. 3
Dentary series 25 teeth occupy a space of	11. 5
Maxillary series 20 teeth occupy a space of	10. 2
Depth of ramus in front of coronoid	3. 0
Length of dental border of maxillary	12. 4
Length of left quadrate	6. 0

The precise geological age of *A. majus* is somewhat uncertain, although the locality given, "Chalk Bluff," is probably an escarpment north and east of Pawnee Buttes and would be the Oreodon beds. Doctor Matthew writes me under date of July 25, 1924, that the Titanotherium beds here "are exposed well out on the plain away from the escarpment."

Genus EXOSTINUS Cope

Exostinus Cope, E. D., Synop. New Vertebrata Tertiary of Colorado, Washington, 1873, p. 16.

Genotype.—*Exostinus serratus* Cope.

A little known genus whose systematic position is uncertain, although it is here provisionally assigned to the family Iguanidae.

Characters.—Sculptured frontal and zygomatic bones; very narrow interorbital region; infolded olfactory ridges but not meeting on median line; teeth pleurodont subcylindric, with simple compressed crowns with a convex edge.

Subsequent to his original description, Cope states the following regarding the affinities of this genus:[24]

> The sculpture of the superior surface of the frontal bone is more like that of *Anolis* than any known to me. The prominent inferior lateral olfactory crests are, however, entirely inconsistent with any such affinity, excluding the genus from the Iguanian group altogether. It coincides with the evidence furnished by the forms of the teeth, that the genus *Exostinus* is one of the Diploglossa, and allied, but not very closely to *Peltosaurus*. In the latter the frontal region is much wider, and is not covered with tubercles, and the olfactory ridges are much less prominent. In its narrow interorbital region *Exostinus* differs from any recent genus of the order known to me.

Later [25] he comments as follows:

> The genus *Exostinus* Cope from the White River beds of Colorado resembles this one [*Xenosaurus grandis*] so far as known, and may enter the same family.

Boulenger[26] regards the Xenosauridae as constituting a connecting link between the Iguanidae and Anguidae.

It is quite apparent from the above that Cope reached no decided conclusion as to the family affinities of *Exostinus*. His expressed opinion that it was allied to *Peltosaurus* has, however, been accepted by subsequent authorities, all of whom have included it in the family Anguidae. After careful study and comparison of the type specimen, I am of the opinion that its affinities may lie in the family Iguanidae, to which it is here provisionally assigned, although the evidence is still inconclusive. Comparison of the type frontal with the corresponding bone of *Phrynosoma* and *Crotaphytus* shows at once that Cope was in error in regarding the presence of "prominent inferior lateral olfactory crests" sufficient evidence for "excluding the genus from the Iguanian group altogether." In both of the above-mentioned genera, more especially *Phrynosoma*, the olfactory crests are equally well developed as in the fossil form, but it is also true that in *Anolis* and *Iguana* these crests are all but lacking. In its narrow interorbital region, *Exostinus* finds its closest resemblance in *Phrynosoma*, and, furthermore, the sculpturing of the superior surface is highly suggestive of the horny tubercular ornamentation of the *Phrynosoma* frontal.

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[24] Cope, E. D., Rep. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 775.

[25] Cope, E. D., Ann. Rep. U. S. Nat. Mus. 1898, p. 539.

[26] Boulenger, G. A., Cat. Lizards in the British Museum vol. 2, 1882, p. 260.

In addition to the resemblances pointed out, a referred specimen (No. 428, Carnegie Museum) shows the coronoid to be without lateral anterior prolongation on the dentary, a condition unknown in the fossil Anguidae, but which prevails in *Phrynosoma*, *Sceloporus*, and *Crotaphytus*. That this feature is not fully indicative of iguanid relationships is shown by the presence of long lateral dentary processes of the coronoid in *Iguana*, *Anolis*, and *Sauromalus*.

The dentition of *Exostinus* offers no features either in support of or against its inclusion in the Iguanidae.

Key to species

Known cranial bones covered with symmetrical osseous prominences	*E. serratus*
Known cranial bones sculptured by diagonal grooves and ridges	?*E. lancensis*

EXOSTINUS SERRATUS Cope

(Pl. 25, figs. 4, 5, 6)

Exostinus serratus Cope, E. D., Synop. new Vertebrata Tertiary of Colorado, Washington, 1873, p. 16; Ann. Rep. Geol. and Geogr. Surv. Terr. for 1873, 1874, p. 514; Rep. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 776, pl. 9, figs. 12–14.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 476.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.—Ung., vol. 21, 1908, p. 39.

Type specimen.—American Museum of Natural History, catalogue No. 1608. Consists of the frontal, dentary with teeth, and zygomatic. Collected by E. D. Cope, 1873.

Type locality.—Cedar Creek, Logan County, Colo.

Horizon.—Oreodon beds, White River formation, Oligocene.

Original description—*Char. gen.*—This form of lizard is represented principally by a nearly entire frontal bone. Close to it were found a zygomatic bone and a nearly complete dentary bone with teeth. The former is in all respects appropriate to the frontal bone, and the size of the dentary bears the usual relation of size to the same. Its dentition is appropriate to the affinities of this genus to *Peltosaurus* Cope.

The frontal bone is much narrowed between the orbits, as in recent leptogloss *Pleurodonta*, while the olfactory lobes were almost completely underarched as in the Thecagloss type. The stout, well developed zygomatic, with malar process resemble the former group, and the teeth have a similar structure. These are closely placed, truly pleurodont and sub-cylindric. The crowns are simple, compressed, and with a convex edge. They are similar in form throughout the dentary bone. Cranial bones covered with symmetrical osseous prominences.

Char. specif.—A series of tubercles along each supraorbital border, longitudinal at the front, quadrate at the back part of the eyebrow. A single series of tubercles separates them. Five tubercles in a transverse row at the posterior margin of the frontal. Two series of flat tubercles on the zygomatic bone. Dentary quite convex on outer face; inner face slightly convex; eight teeth in M. 0.0050.

Measurements

	Mm.
Length of frontal (nearly complete)	0. 0070
Width of frontal posteriorly	. 0034
Width of frontal at postorbital point	. 0045
Width of frontal between orbits	. 0018
Length of zygomatic	. 0070
Depth of dentary at last tooth	. 0030
Length of a mandibular tooth	. 0018

Cope has fully described the type specimen, but a poorly preserved skull in the Carnegie Museum (No. 428) articulated with the greater portion of both rami, if correctly referred to the present genus and species, contributes considerably to a better understanding of this form. This specimen was collected by Mr. O. A. Peterson on Prairie Dog Creek, Sioux County, Nebr., in 1901, and comes from the same geological level (Oreodon zone of the Oligocene) as the type. Originally the skull and lower jaws were very complete, but subsequent erosion has worn away all of the top and much of the sides of the skull. The jaws are complete except for the loss of anterior portions of both dentaries. The occipital region of the skull is intact; the right quadrate and a portion of the right maxillary containing six teeth is about all that remains of the lateral portion.

The dentition, so far as it can be observed, agrees with the type in size, and in the compressed, simple nature of the tooth crowns with convex edge. The maxillary shows no sculpturing of its external surface. The upper teeth are similar to the lower. The occiput is strongly inclined to the vertical, with a rounded median longitudinal ridge that fades out before reaching the border of the foramen-magnum. This foramen is large, suboval, wider than high; occipital condyle tripartate, strongly reniform in outline.

The quadrate has a greatest length of 4.9 millimeters and stands nearly perpendicular in relation to the lower jaw. Other features of this bone are not to be observed in its present condition.

The relationships of the bony elements forming the lower jaw are clearly shown in Figure 8. The angular is narrowly visible from a lateral view. The coronoid is contracted anteroposteriorly and does not develop an anterior lateral process, as in many of the lizards, a feature that would at once separate it from all known extinct Anguidae. In this respect it agrees with the iguanid genera *Phrynosoma, Crotaphytus, and Sceloporus.* A similar condition is found in the extinct *Aciprion,* although the dentary does not develop an overlapping process as in the present genus. The articular and surangular are fully coalesced. The external face of the dentary is strongly convex.

A specimen in the Yale University Museum (No. 1076) is also referred to this species. It consists of the posterior half of a right dentary bearing teeth. It was found in a vial with No. 1066 (*Peltosaurus granulosus*) and its history is unknown.

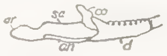

FIG. 8.—Diagrammatic outline of right ramus of *Exostinus? serratus* Cope. (No. 428, Carnegie Museum.) About natural size. *an*, angular; *ar*, articular; *co*, coronoid; *d*, dentary; *sa*, surangular

?EXOSTINUS LANCENSIS, new species

(Pl. 26, fig. 2; pl. 27, figs. 2, 2a)

Type specimen.—United States National Museum, catalogue number 10,689. Consists of the right maxillary, lacking the anterior extremity, containing a series of five posterior teeth.

Type locality.—Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

Of the specimen selected as the type, we have no knowledge as to the exact locality, date of discovery, or collector. It was found among a miscellaneous lot of fossil bones that had been sifted out of sand, known to collectors as "mammal sand," in the quest for mammalian teeth and jaws. This came from somewhere along Lance Creek, Niobrara County, Wyo., and most of it was collected by or under the direction of the late J. B. Hatcher.

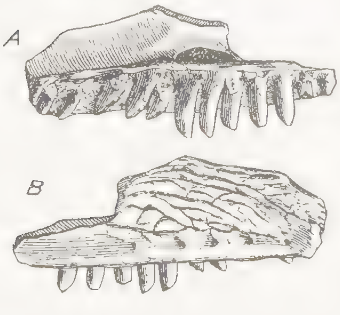

FIG. 9.—Right maxillary of ?*Exostinus lancensis* Gilmore. Type. (No. 10689, U. S. Nat. Mus.) About five times natural size. A, inner view; B, outer view

The type maxillary has the external surface sculptured by diagonal grooves that run upward and backward from a narrow smooth band that extends all along the tooth border and is perforated at intervals by a row of five foramina. The diagonal grooves are joined here and there by connecting depressions, thus cutting the surface into ridges of irregular shape and many sizes, but all having a diagonal trend in relation to the alveolar border as shown in Figure 9B.

The teeth are closely placed, pleurodont, and subcylindric. The crowns are simple, compressed traversely, anterior edge much longer than posterior, which places the point of the tooth well back of the center and gives the teeth an appearance of raking backward. All preserved are similar in form. The five teeth occupy a space of 3 millimeters. As preserved the maxillary measures 8 millimeters in length and there is evidence of the presence of 13 teeth.

This species is provisionally referred to the genus *Exostinus* on account of the sculptured surface of the skull bones and the general similarity of the teeth, though more complete materials are necessary before its generic reference can be assured.

A parietal bone (No. 10725, U. S. National Museum) from "Peterson's quarry" on Lance Creek, Niobrara County, Wyo., collected by J. B. Hatcher in 1891, is provisionally referred to the present species. The presence of sculpturing (see pl. 27, fig. 2), resembling somewhat that found on the maxillary of the type (fig. 9), suggests the association. This relationship is further suggested by the straight frontoparietal suture and the presence of a distinct pineal foramen. Most of the posterior half of the superior surface is without sculpturing. Both posterior-lateral processes of the parietal are missing. The posterior median border presents a shallow concave notch as in *Peltosaurus*. This bone has a greatest length at the center of 9 millimeters; a width between the supratemporal fossae of 7 millimeters.

Genus CHAMOPS Marsh

Chamops, Amer. Journ. Sci., 3d ser. vol. 43, 1892, p. 450.

Genotype.—*Chamops segnis* Marsh.

Characters.—Teeth pleurothecodont; internal and external surfaces of teeth grooved longitudinally; tricuspid; subequal in size; 23 teeth in complete dentary series.

An imperfectly known genus whose systematic positon is uncertain. Marsh made no suggestion as to the systematic affinities of *Chamops*, but Boulenger[27] referred it without comment to the Teiidae; Hay[28] placed it in the Iguanidae; Nopcsa[29] accepted Boulenger's opinion and referred it to the Teiidae. Camp[30], however, basing his observations largely on a dentary containing teeth (No. 988, American Museum of Natural History, fig. 11), feels that the genus is most closely related to iguanid stock. His very interesting discussion of this form is given below:

> Marsh's specimen differs from the teiids in having a strictly homodont type of dentition and our specimen seems to agree in this particular. Also the trilobate teeth are not developed anteriorly in the teiids, and even in the posterior teeth the lateral cusps are not so large as in *Chamops*. The teeth seem to be closest among living lizards to those of certain nonspecialized Iguanidae (cf. *Crotaphytus collaris*), agreeing with these in the swollen base, ratio of height to diameter of crown, form of cusps, in homodonty, and in the fact that a line drawn through the summit of the crowns is straight. They differ in being pleurothecodont rather than strictly pleurodont, and they are more completely exposed externally than in recent iguanids.
>
> We may not consider *Chamops* an iguanid on account of lack of definite characters, but feel that among living lizards it is most closely related to that stock. In tooth insertion it seems to partially bridge the wide gap between pleurodont and hyperacrodont Ascalabota (Iguanidae and Agamidae and Rhiptoglossa).
>
> The trilobate teeth of generalized iguanids and agamids and the Rhiptoglossa do not differ materially in form. In the two latter groups such a high degree of acrodonty is attained, coupled with a slicing, shear-like motion of the mandible, that the tooth shafts have come into view more on the outside than the inside of the dentary. To account for this extraordinary digression by closely related groups is a difficulty perhaps best hypothecated by regarding the thecodont or pleurothecodont type of tooth insertion seen in Jurassic Euposauridae and the Cretaceous *Chamops* as a slight advance upon the typically thecodont condition of the Permian *Araeoscelis*. It is obvious that the stage illustrated by *Chamops* would more easily lead, on the one hand, to typical pleurodonty and, on the other, to acrodonty, than the derivation of the highly developed agamid type of acrodonty from iguanid pleurodonty or vice versa.

A study of all available specimens throws no additional light on the systematic relationships of this genus, which now contains two species, both from the Lance formation, Upper Cretaceous, of Wyoming.

Key to species

Eight teeth of dentary occupy space of 10.5 millimeters	*C. segnis.*
Sixteen teeth of dentary occupy space of 10.5 millimeters	*C. denticulatus.*

CHAMOPS SEGNIS Marsh

Chamops segnis Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 43, 1892, p. 450, figs. 2, 3.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 474.—Bowen, C. F., Prof. Paper U. S. Geol. Surv., No. 90–I, 1915, pp. 128, 129.—Nopcsa, F. B., Beiter. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 38 (as *C. seguis*).—Camp, C. L., Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p. 309.

Type specimen.—Yale University Museum, catalogue No. 1036. Consists of the right maxillary bone containing five perfect teeth. Collected by J. B. Hatcher, 1889.

Type locality.—Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

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[27] Zool. Record, London, 1892.

[28] Bull. U. S. Geol. Surv., No. 179, 1902, p. 474.

[29] Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 40.

[30] Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p. 309.

Original description.—The type specimen of the present genus is the maxillary bone with teeth represented in Figures 2 and 3 below. Various other parts of the skull and skeleton have been found at different localities in the same horizon, but it is not certain that they pertain to the same species. Dentary bones with precisely similar teeth and corresponding in size with the jaws figured have been secured, and there can be little doubt of their identity. Among the other portions of the skull obtained is the upper part of the cranium. This has the surface very rugose, and is perforated by a large parietal foramen.

Various vertebrae found at the same localities may be referred to this species. They are procoelian, with the cup and ball transverse and oblique. These are all without the zygosphene articulation.

The pleurothecodont teeth have laterally compressed crowns with a median conical denticle that rises but little higher than the smaller single denticles that border it both in front and back. Internally the accessory denticles are separated from the median ones by shallow but well-defined perpendicular grooves that extend downward nearly to the level of the outer alveolar border of the jaw. Externally the upper median surface of each tooth is sculptured by a number of short perpendicular grooves that do not extend downward so far as the two internal grooves described above. They also disappear before reaching the apex of the median cone. The teeth, where broken off low down, seem to have thin walls, hollow bases, and are subquadrangular in cross section, the transverse exceeding the anteroposterior diameter. They are set in alveoli, as is clearly shown in Figure 11.

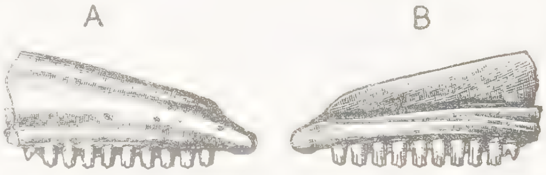

FIG. 10.—Right maxillary of *Chamops segnis* Marsh. Type. (No. 1036, Yale University Museum.) Twice natural size. A, outer view; B, inner view. (After Marsh)

The external surface of the maxillary is smooth except for the usual row of foramina which parallels the alveolar border. This surface is broadly convex from above downward. The anterior end seems to be nearly complete. On the outer anterior surface of this end a broad, shallow depression appears to indicate the overlap of a process of the premaxillary. (See fig. 10A.) If my interpretation of this depression is correct, it indicates quite a different union of these bones from that generally found; usually the contact is vertical or else the maxillary overlaps the premaxillary. The evidence, however, is so inconclusive that it appears unprofitable to speculate on it further.

The greatest length of the type maxillary, which lacks both extremities, is 17.2 millimeters; in this there is evidence of 13 teeth, 8 of which occupy a space of 10.5 millimeters. The greatest depth of the maxillary from the point of the most posterior complete tooth is 7.8 millimeters. A median portion of a right maxillary in the collections of the United States National Museum (No. 8264) contains three complete teeth and the basal portions of five others. It agrees so perfectly in size and other characteristics that it may be definitely referred to the present species. A right dentary carrying three complete teeth and the basal portions of several others (No. 988, American Museum of Natural History) is also so referred. In this specimen, which lacks some of its posterior extremity, there is evidence of 16 teeth, occupying a span of 14 millimeters. Whereas eight of the median upper teeth of the type occupy a space of 10.5 millimeters, a similar number in this specimen only require 8.5 millimeters. In tooth proportions, therefore, specimen No. 988 appears slightly smaller than the type and in this respect intermediate between *C. segnis* and *C. denticulatus*. Since it is known that in

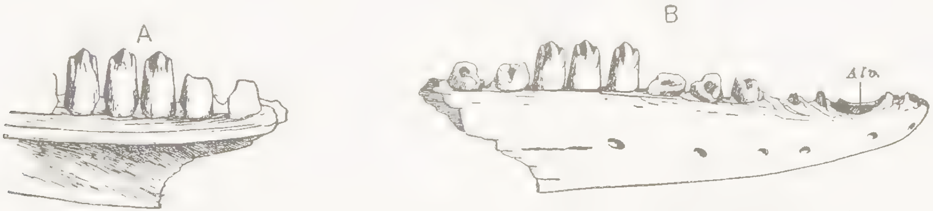

FIG. 11.—Right dentary of *Chamops segnis* Marsh. (No. 988, Amer. Mus. Nat. Hist.) About four times natural size. A, inner view; B, outer view; *Alv*, alveolus. (After Camp)

some lacertilian forms the upper teeth are slightly more robust than the lower, there would appear to be no reason why this specimen should not be regarded as of the present species.

In his original description Marsh mentions having "dentary bones with precisely similar teeth." I have found only one such dentary in the Yale Museum's collection (No. 1062), and a comparison with the type shows differences which indicate its specific distinctness, and I have made it the type of the new species, *C. denticulatus*. The "upper part of the cranium" mentioned is evidently a specimen from the same locality as the type, No. 1063, Yale University Museum, a parietal bone lacking some of its posterior extremity. (See pl. 27, fig. 3.) This element clearly belongs to a large lizard. Its great size is out of all proportion to the type and other specimens here referred to *C. segnis*, and on that account may be dismissed from further consideration in this connection. The "various vertebrae" were arbitrarily associated and could with equal propriety be regarded as belonging to any one of the several forms from the same horizon and locality which have now been described. No two bones in the entire collection of small mammal and lacertilian remains from the Lance formation were ever found in such relation as to be definitely assigned to a single individual. *Chamops segnis*, therefore, so far as the original materials mentioned by Marsh are concerned, rests entirely on the maxillary bone, and it alone must be regarded as the type specimen.

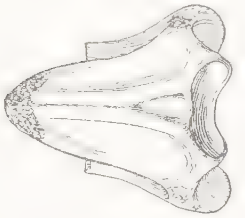

FIG. 12.—Vertebral centrum provisionally referred to *Chamops segnis* Marsh. (No. 10943, U. S. Nat. Mus.) Three times natural size. Ventral view

In the collections of the United States National Museum is a single dorsal vertebra, No. 10,943 (see fig. 12), from the Lance formation of Niobrara County, Wyo., which, on account of its tapering centrum, large condyles, and close resemblance to the agamid lizard *Colotes* (see fig. 13) appears typically Iguanid. Much of the arch is missing, and due to abrasion the true contours of the ball are lost. Provisionally it is regarded as possibly pertaining to the present genus and species, though its chief interest lies in the additional evidence it gives of the presence in the Lance of Sauria which certainly pertain to either the Iguanidae or Agamidae.

REFERRED SPECIMENS

No. 988, American Museum of Natural History. A nearly complete right dentary containing three perfect median teeth. Lance formation, Upper Cretaceous, Niobrara County, Wyo. Collected by the American Musuem of Natural History expedition of 1892.

No. 8264, United States National Museum. Posterior half of a right maxillary containing three complete teeth and the basal portions of five others. Lance formation, Upper Cretaceous, "Peterson's quarry," Niobrara County, Wyo. Collected by J. B. Hatcher, 1889.

No. 111, American Museum of Natural History. Median portion of a maxillary bone containing three complete teeth and the basal portions of three others. Lance formation, Upper Cretaceous, Niobrara County, Wyo. Collected by the American Museum Expedition, 1892.

CHAMOPS DENTICULATUS, new species

(Pl. 27, fig. 5)

Type specimen.—Yale University Museum, catalogue No. 1062. Consists of the complete left dentary containing 23 teeth. Collected by J. B. Hatcher, 1889.

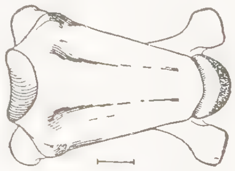

FIG. 13.—Vertebral centrum of *Calotes versicolor* (Daud), an agamid lizard. Ventral view. (After Camp)

Type locality.—"Peterson's quarry," Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

As stated before, the type specimen of this species is apparently one of those mentioned by Marsh in his original description of *Chamops segnis* as "dentary bones with precisely similar teeth and corresponding in size with the jaws figured." That the dentary bone now before me is one of those referred to is indicated by the name *Chamops segnis* written on the bottom of the box containing it.

The features of the type specimen which are regarded as distinctive are the small teeth without swollen shafts and the absence of sculpturing on the external faces of their crowns. Where *C. segnis* has 8 teeth occupying a space of 10.5 millimeters, there are 16 in the same length of alveolar border in *C. denticulatus*. The complete tooth series of the dentary as shown by the type specimen consists of 23 teeth, all of about equal size. The teeth are laterally compressed, with tricuspid crowns, consisting of a median conical denticle, bordered in front and back by a single and much smaller denticle that are less distinctly set off from the median one than in *C. segnis*, though, as in that species, there are perpendicular grooves extending downward on the internal face from the superior division of the denticles. The external faces of the teeth are devoid of sculpturing. The broken roots show the bases of the teeth to have been hollow and with a greater transverse than anteroposterior diameter as in *C. segnis*.

Below the teeth on the internal side of the jaw is the usual Meckelian groove. The symphysis was very small and weak. (See fig. 14A.) The outer face exhibits six vasculo-neural foramina all situated on the anterior third of the dentary. The posterior end is rather deeply concave from above downward, with a short projecting spur at the center of the concavity. (See pl. 27, fig. 5.) The dentary has a greatest length of 14.8 millimeters; a depth from the point of the fourth tooth from the last of 4.9 millimeters.

REFERRED SPECIMENS

No. 10,805, United States National Museum. Fragment of a dentary carrying four teeth, provisionally referred to this species. Collected by J. B. Hatcher in 1891 from the same geological horizon on Lance Creek as the type specimen. It represents an individual smaller than the type, and the median denticle is more acutely pointed with more of an inclination inward and backward than found in the teeth of the type. More perfect material might show this specimen to represent a new form, but for the present it seems best to refer it to the present species.

No. 10,919, United States National Museum. Fragment of a maxillary bearing one tooth, tentatively referred. Lance formation, Upper Cretaceous, Lance Creek, Niobrara County, Wyo. Collected by J. B. Hatcher, 1892.

No. 112, American Museum of Natural History. Fragment of a jaw carrying three teeth; provisionally referred. Lance formation, Upper Cretaceous, Niobrara County, Wyo. Collected by American Museum expedition of 1892.

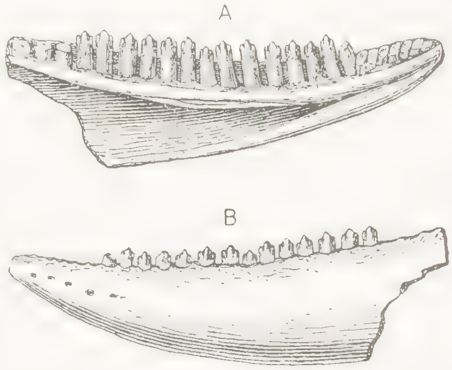

Fig. 14.—Left dentary of *Chamops denticulatus* Gilmore. Type. (No. 1062, Yale Museum.) Four times natural size. A, inner view; B, outer view

No. 113, American Museum of Natural History. Fragment of a jaw carrying four teeth. Lance formation, Upper Cretaceous, Niobrara County, Wyo. Collected by the American Museum expedition of 1892.

Genus Parasauromalus, new genus

Genotype.—Parasauromalus olseni, new species.

Characters.—Teeth pleurodont; crowns laterally compressed, acutely spoon-shaped; tricuspid posteriorly; teeth closely placed in jaw.

This genus is provisionally referred to the Iguanidae because of resemblances in the dentition to that of the living *Sauromalus ater*.

Parasauromalus olseni, new species

Type specimen.—American Museum of Natural History, catalogue No. 1620. Consists of a portion of the right dentary bearing five complete teeth and the basal portions of eight others. Collected by George Olsen, 1909.

Type locality.—Alkali Creek, Fremont County, Wyo.

Horizon.—Wind River, Middle Eocene.

The right dentary selected as the type specimen of the present genus and species lacks portions of both ends. This jaw fragment shows evidence of the presence of 14 teeth, of which 5 posterior ones are completely preserved. Six posterior teeth occupy a space of 5.5 millimeters.

The teeth (see fig. 15) present a style of crown structure not before observed among the fossil Sauria, its closest resemblances being with the living *Sauromalus ater*. The species is named for Mr. George Olsen, who collected the type specimen.

The teeth are pleurodont, with long shafts closely crowded together in the jaw; crowns laterally compressed, acutely spoon-shaped, with tip directed inward as in *Sauromalus*. The anterior teeth were probably simple, but the posterior are tricuspid. The small lateral cusps are set off by shallow vertical grooves. Two parallel grooves on the inner anterior face not only help to define the lateral cusp, but one of these really bisects its inner face. The inner or median cusp has the crown surfaces delicately striated at right angles to the cutting edge on both inner and outer faces, which gives the edge the appearance of being serrate. These features are only to be observed under a powerful glass.

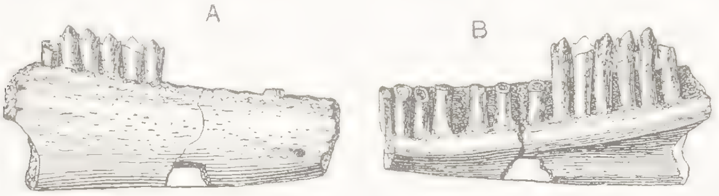

FIG. 15.—Right dentary of *Parasauromalus olseni* Gilmore. Type. (No. 1620, Amer. Mus. Nat. Hist.) Three times natural size. A, outer view; B, inner view

The general resemblance of the teeth to those of *Sauromalus*, some having excavated bases suggesting a similar tooth replacement, Meckelian groove closed anteriorly and relatively short splenial, are all features suggesting that its affinities lie in the family Iguanidae, to which it is provisionally referred.

The type specimen represents an individual slightly larger than an adult of *Sauromalus ater* which is now before me.

Measurements

	Mm.
Greatest length of dentary fragment	14. 6
Greatest length of posterior tooth	3. 0
Greatest depth posterior end of dentary	5. 5

Genus PHRYNOSOMA Wiegmann

Phrynosoma Wiegmann, Isis, 1828, p. 367.

Genotype.—*Phrynosoma orbiculare* Wiegmann.

There is no mention made by Stejneger and Barbour[31] of any of the living species ranging into Arkansas, although Cope[32] lists the occurrence of specimens of *P. cornutum* as coming from that State.

PHRYNOSOMA sp.

(Pl. 27, fig. 4)

Lacertian sp., Brown, B., Memoirs Amer. Mus. Nat. Hist., vol. 9, pt. 4, 1908, pp. 166, 207, pl. 22.

In the memoir cited above Brown states:

> A lizard not unlike those found living in the woods near the Conard fissure at the present time is represented by 11 jaws.

Among the remains of Sauria transmitted to me for study by the American Museum of Natural History is a small tray containing 11 specimens bearing the catalogue No. 6405. These were all collected by Barnum Brown in 1903 from the Conard fissure, 4 miles west of Willcockson, Newton County, Ark., and are of late Pleistocene age. If they are the same specimens referred to by him, none of them agree with his figures on Plate 22 of his paper. Two right maxillaries, one left maxillary, a posterior portion of a right dentary, and a posterior portion of a ramus are identified as pertaining to the genus *Phrynosoma*. In size, in the vertical position of the superior process of the maxillary, and in the number and subconical shape of the pleurodont teeth (see pl. 27, fig. 4) the maxillae agree perfectly, and appear to indicate their generic affinities to be with the existing genus *Phrynosoma*. At the present time I see no way of distinguishing these specimens from the living species.

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[31] Check list of North American Amphibians and Reptiles, 1917, pp. 57–60.

[32] Ann. Rep. U. S. Nat. Mus., 1898 (1900), pt. 2, p. 435

Genus CROTAPHYTUS Holbrook

Crotaphytus Holbrook, N. Amer. Herpetologist, ed. 2, vol. 2, 1842, p. 79.

Genotype.—Crotaphytus collaris (Say).

?CROTAPHYTUS sp.

(Pl. 27, fig. 6)

In a collection of vertebrate fossils made by Dr. J. W. Gidley and Dr. Kirk Bryan in southern Arizona in 1921 is the median portion of a left dentary of a lacertilian. This specimen, No. 10,690, United States National Museum, comes from a quarry located 2 miles south of Benson, Cochise County, Ariz., from which a micro-fauna [33] was obtained that is regarded as of Pliocene age.

This fragmentary dentary bears 10 pleurodont teeth. They are subcylindric, with slightly compressed crowns; anterior teeth simple and sharply pointed; median teeth unequally bicuspid; teeth inclined slightly backward. The dentary bone as now preserved lacks both extremities and much of its lower border (see pl. 27, fig. 6), so that any determination based on this specimen must rest on the characters found in the teeth.

In size and tooth structure the specimen closely resembles the living *Crotaphytus* and on that account is provisionally referred to that genus.

Section **RHIPTOGLOSSA**

Rhiptoglŏssa, Wiegmann, Herp. Mex., 1834, p. 6.

Vertebrae always procoelous with large condyles and no intercentra; centra elongate, cylindrical; tongue vermiform and extensile; skull arches complete; three cervical vertebrae.

Family CHAMAELEONIDAE

Skull usually forms a bony casque, ornate with crests or tubercules. Interorbital septum present and small columella cranii distinguishable. Premaxillary extremely small, edentulous; orbit bony all around; the pre and post frontals after joining form a supraorbital roof; a pair of supranasal fontanelles, bordered by the nasals, the prefrontals, and the frontal; latter bone single; "parietal" foramen, if present, pierced in the frontal; parietal single, often much narrowed and compressed, forming a crest and meeting posteriorly the extremities of a pair of bones, the supratemporals, which on each side connect it with the squamosal. In some species the parietal in the adult may be much expanded and form a bony slab from which the supratemporals are no longer to be distinguished. Premaxillary nearly always separated from vomers by maxillaries, pterygoids not touching body of sphenoid or reaching quadrate. Dentition acrodont; teeth compressed, triangular, more or less distinctly tricuspid. Palate toothless, coronoid bone produced posteriorly on outside of ramus, articular present, separate from angular. Splenial reduced, more frequently wanting. Subarticular small on outer, much prolonged on inner face of ramus. Groove from splenial to mental foramina not closed over Meckel's cartilage. No angular process of mandible. Vertebrae procoelain. A sternum without fontanelle. Abdominal ribs present. Interclavicle absent. Limbs long, raising the body. Digits arranged in bundles of two and three; in the hand, the inner bundle is formed of three, the outer of two digits; it is the reverse in the foot. No osseous scales.

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[33] Gidley, J. W., Prof. Paper 131–E, U. S. Geol. Surv., 1922, p. 120.

About one half of the 50 living species occur in Madagascar and neighboring islands, the other half in North Africa; the common chameleon is Mediterranean, occurring in Europe, however, only in Andalusia; a species inhabits Socotra, another South Arabia, and a third India and Ceylon.

All living chameleons are insectivorous.

The fossil record of this family is very unsatisfactorily known. At this time there are no undoubted extinct chameleons. *Paleochameleo* of De Stephano [34] from the Eocene (Quercy) of France, and *Tinosaurus* of Marsh from the Eocene (Bridger) of Wyoming, constitute the only extinct genera assigned to this family, both established on fragmentary jaws. *Chamaeleo* of Leidy, also from the Bridger, is here regarded as being congeneric with *Tinosaurus* and hence becomes a synonym of the latter on the grounds of priority.

Both *Paleochameleo* and *Tinosaurus* have acrodont dentition, but, so far as any positive evidence goes, I agree with Camp [35] that they can equally well be placed in the Agamidae. For the present, I propose to continue the American forms in the family Chamaeleonidae.

Genus TINOSAURUS Marsh

Tinosaurus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, Oct., 1872, p. 304.
Chamaeleo Leidy, J., Proc. Acad. Nat. Sci. Philadelphia, Dec. 10, 1872, p. 277.

Genotype.—*Tinosaurus stenodon* Marsh.

Characters.—Teeth typically of small size, acrodont; short, laterally compressed, pointed apices, tricuspid posteriorly, denticles reducing anteriorly; anterior teeth with or without lateral cusps; vertical grooves between teeth on external side of ramus caused by wear of opposing upper teeth. Teeth reducing in size from back to front.

In proposing the genus *Tinosaurus,* Marsh made no attempt to define it, nor did he offer any suggestions as to its family affinities, except that in describing a second species, *T. lepidus*, he observes that the teeth "resemble those in the *Chamaeleon.*" Zittel [36] referred it to the Varanidae and Hay [37] doubtfully regarded it as belonging to the same family.

Comparison of the types of *Tinosaurus* Marsh and *Chamaeleo* Leidy shows such close resemblances, especially in the character of the dentition, as to leave no doubt of their generic identity, and *Tinosaurus* having priority by two months, *Chamaeleo* becomes a synonym. This is, in a way, unfortunate as the specimen upon which the latter was established is the much more adequate of the two.

Leidy said nothing as to the systematic position of *Chamaeleo,* though it is evident from the name selected that he regarded it as close to the living genus *Chamaeleo,* and therefore referable to the family Chamaeleonidae, the position assigned it by Hay.[38] Matthew[39] regards "the recorded presence of *Chamaeleo* [*C. pristinus*] in the Upper Cretaceous [Middle Eocene] is improbable and based upon insufficient evidence."

Camp,[40] after a comparison of Leidy's figures with *Calotes*, an agamid lizard, and with *Chamaeleo gracilis* and *C. vulgaris,* fails to find any "diagnostic peculiarities in the parts preserved in the fossil, between teeth of any of these forms, and therefore prefer to place '*Chamaeleo pristinus*' among the Ascalabota as either an agamid or chamaeleontid." As stated above, I fully concur in this conclusion as expressing our certain knowledge of this form, but, notwithstanding the doubt cast on its rhiptoglossid affinities, I shall refer the genus *Tinosaurus* to the Rhiptoglossa and provisionally to the family Chamaeleonidae.

Two species are recognized, *Tinosaurus stenodon* Marsh and *T. pristinus* (Leidy). *Tinosaurus lepidus* Marsh is regarded as a synonym of T. *stenodon.*

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[34] Atti Soc. Ital. Sci. Nat. Mus. Civ. Milano, vol. 42, 1903, p. 391.
[35] Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p. 312.
[36] Handbuch der Pal., vol. 3, 1890, p. 609.
[37] Bull. U. S. Geol. Surv., No. 179, 1902, p. 478.
[38] Op. cit.
[39] Ann. New York Acad. Sci., vol. 24, 1915, p. 289.
[40] Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p. 310.

Key to species

Typically larger than *T. pristinus*, teeth more swollen; dentary teeth with two, one, and no lateral denticles	*T. stenodon.*
Typically smaller than *T. stenodon*, teeth with median denticle conical; dentary teeth all tricuspid, except possibly the first	*T. pristinus.*

TINOSAURUS STENODON Marsh

(Pl. 2, figs. 14, 15)

Tinosaurus stenodon Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872. p. 304.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 476.

Thinosaurus stenodon Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 47.

Tinosaurus lepidus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 308.—Hay, O. P., Bull. U. S. Geol. Surv., No.179, 1902, p. 476.

Thinosaurus lepidus Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 47.

Type specimen.—Yale University Museum, catalogue number 615. Consists of a portion of a right dentary containing two complete teeth and the basal portion of a third. Collected by J. F. Page, September 22, 1871.

Type locality.—Near Henry's Fork, Unita County, Wyo.

Horizon.—Horizon C or higher, Bridger formation, Middle Eocene.

Original description.—A small carnivorous lizard is indicated among our Wyoming fossils, by part of a lower jaw, with two teeth, in excellent preservation, and by some other fragmentary specimens. The teeth preserved are from near the middle of the lower jaw. Their crowns are short, much compressed, pointed and curved backward. They are separated from each other by about half the diameter of the crown. The anterior tooth is the larger, and has on its front edge a small cusp. The posterior tooth is tricuspid. On the outside of the jaw in front of each tooth, is a groove cut by the opposing upper tooth, which was likewise compressed and swollen. The animal thus represented was probably less than two feet in length.

Measurements

	Mm.
Space occupied by three lower teeth	4. 5
Height of crown of lower tooth above jaw	1. 0
Antero-posterior diameter at base	1. 8
Transverse diameter of jaw below teeth	2. 0

The above brief description covers all of the salient features of the type specimen, except that the firm ankylosis of the teeth to the jaw bone should be mentioned. The teeth are subacrodont, by which I mean that they are not typically acrodont as in *Sphenodon* but are firmly ankylosed to a short but inclined surface on the internal side of the jaw, as is clearly shown in Figure 15, Plate 2.

It is somewhat difficult to understand Marsh's reference to an "opposing upper tooth." Nowhere in the Yale collection of lizards is there an upper tooth which by any stretch of the imagination could be referred to this genus.

A second species, *Tinosaurus lepidus*, described by Marsh, was based on the symphysial portion of a left dentary, No. 1053, Yale Museum, collected by O. Harger September 20, 1871, from the same locality and horizon as *T. stenodon.* (See pl. 2, fig. 14.) The original description is given below:

Original description.—A species of very small lizards apparently belonging to the genus *Tinosaurus* may be established on some fragmentary remains among our Wyoming fossils. One of these is the anterior half of a lower jaw in good condition. The teeth in this specimen are compressed and closely resemble those in the chameleon. The rami of the lower jaw were stout, and not deep, and met each other at a considerable angle. The symphysis is short, and its surface nearly smooth, showing that the rami were but slightly attached. The groove for Meckel's cartilage is unusually large. The animal represented by the remains preserved was probably not more than a foot in length.

Measurements

	Mm.
Space occupied by four anterior lower teeth	4. 0
Depth of jaw below fourth tooth	2. 0
Width of jaw at this point	1. 6
Length of symphysis	2. 0

It will be observed that Marsh did not in any way contrast or distinguish this specimen from *T. stenodon*, and after a careful study and comparison with the type of that species there would appear to be little doubt that they pertain to one and the same species. The teeth are of the same general character, but the absence of lateral cusps on these anterior teeth is a condition to be expected—in fact, is predicated by the presence of only one denticle on the anterior tooth as preserved in the type specimen of the genus, while the posterior one has two. (See pl. 2, fig. 15.) That this change takes place in the dental series appears to be further substantiated by the apparent absence of one if not both lateral denticles in the small but most anterior tooth in *T. pristinus*. In this connection it would seem that the type specimen, instead of representing a portion of the middle of the jaw, as stated by Marsh, belongs to the anterior half of the dentary, a conclusion borne out by comparison with the more complete dentary of *T. pristinus*. A third specimen (No. 1093, Yale Museum) referable to this species, consisting of a fragment of a dentary bearing two tricuspid teeth, bears out the above conclusion, for it is quite evident that this fragment is from the middle or posterior part of the dentary bone. The specimen is from the Eocene, Bridger formation of Wyoming, and was collected by L. La Mothe and J. W. Chew in August, 1874.

Tinosaurus pristinus (Leidy)

(Pl. 2, figs. 16, 16a)

Chamaeleo pristinus Leidy, J., Proc. Acad. Nat. Sci. Philadelphia, 1872, p. 277; Rep. U. S. Geol. Surv. Terr., vol. 1, 1873, pp. 184, 345, pl. 27, figs. 38, 39.—Palacky, J., Zool. Jahrh., Abt. Syst. Geog. u. Biol., vol. 12, 1899, p. 281.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 478.—De Stefano, G., Atti Soc. Ital. Sci. Nat. Mus. Civ. Milano, vol. 42, 1903, p. 392.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21 1908, p. 38 (gen. ref. as *Cameleo*, p. 49).—Matthew, W. D., Annals New York Acad. Sci., vol. 24, 1915, p. 281 (as Chamaeleon).—Abel, O., Die Stämme der Wirbeltierre, 1919, p. 679.—Camp, C., Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p. 310.

Type specimen.—Philadelphia Academy of Sciences, catalogue No. 9134. Consists of the median portion of the right dentary containing eight teeth. Collected by Dr. J. Van A. Carter.

Type locality.—Probably Uinta County, Wyo.

Horizon.—Bridger formation, Middle Eocene.

> *Original description—Chamaeleo pristinus.*—Indicated by a lower jaw fragment containing eight teeth in a space of five lines. In every respect it agrees in character with the corresponding part in living species of the genus.

In the following year Leidy contributed the following additional description:

> The teeth are laterally compressed conical, with the borders in front and behind somewhat extended and acute, and at the base produced into a minute denticle. Externally the bases of the teeth are separated by perpendicular furrows descending on the face of the jaw to the position of a finely perforate horizontal line. Beneath the bases of the teeth internally there is a wider and more conspicuous horizontal and perforated groove. Below this, toward the rounded base of the jaw, the usual Meckelian groove is situated. The outer face of the jaw exhibits two vasculo-neural foramina. The depth of the lower jaw from the point of the last tooth of the specimen is 2½ lines.

The above fully describes the type specimen. Since Leidy studied and illustrated it, the specimen has apparently suffered the loss of the crowns of several teeth, as may be seen by a comparison of his figures with Figures 16 and 16a, Plate 2.

Dentary as preserved measures 11.2 millimeters in length. The eight teeth occupy a space of 9.4 millimeters; the depth of the dentary from the point of the last tooth is 4.9 millimeters, and from the point of the second tooth from the anterior end the depth is 3.4 millimeters.

The "perpendicular furrows" mentioned as separating the teeth on the external side (see pl. 2, fig. 16) are undoubtedly grooves cut by the opposing teeth of the upper jaw. A similar grooving is observed in the type of *Tinosaurus stenodon* and also in the living *Chamaeleon roperi* (No. 65513, U. S. National Museum). It was at first thought that this perpendicular grooving was a peculiarity obtaining only in the Chamaeleonidae, but examination of the jaw of the agamid lizard *Calotes* shows a similar grooving, so that this mechanical feature is of no assistance in determining the affinities of these species.

Division Autarchoglossa

Autarchoglossa, Wagler, Nat. Syst. der Amphibien, etc., 1830, p. 152.

Section SCINCOMORPHA

Scincomorpha Camp, Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, pp. 296, 298.

Clavicles, when present, usually dilated, often perforate, and sometimes hook-shaped; interclavicle, when present, usually cruciform; osteoderms, when present, compound on the ventral surface of the body; tooth replacement usually directly successive by intrusion of new tooth into hollow base of old; teeth rarely conical and recurved, caudal chevrons, when present, always intercentral or slightly post-intercentral.

Superfamily AMPHISBAENOIDEA

Vertebrae with broad, flat centra and wide condyles, subcentral arterial foramina present as in geckonids and pygopodids; no neural spines, no intercentra; dorsal scales granular or tubercular when present; skin usually naked; no osteoderms; no parasternum.

Family AMPHISBAENIDAE

Teeth large, few, ankylosed to the inner or upper edge of the jaws; premaxillary teeth usually in odd numbers; no pterygoid teeth. Skull thick, strongly ossified, without interorbital septum or columella cranii, and frontosquamosal arches; without postorbital arch except in *Hyporhina;* premaxillary single; nasals two; frontals two; parietal single, very large; an orbitosphenoid bone; quadratum very oblique, or nearly perpendicular; occipital condyle frequently divided. Vertebrae very numerous, procoelus, depressed, ball transversely oval all except the foremost without spinous processes. Pectoral arch imperfectly developed in *Chirotes,* reduced to minute rudiments on other limbless forms; pelvic arch reduced to minute rudiments.

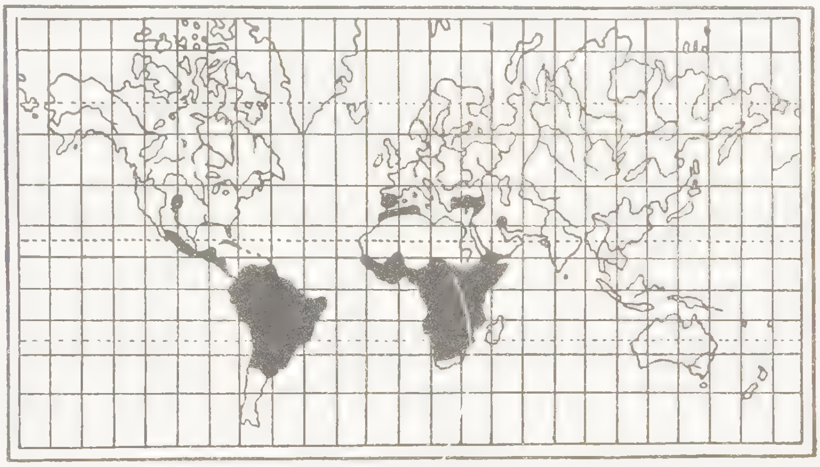

FIG. 16.—Map showing the past and present distribution of the Amphisbaenidae. Modified from Schmidt

The shape of the skull varies considerably in the different genera. The mandible especially undergoes the greatest modifications. The angular bone is chiefly developed on the internal side of the ramus, and the splenial is very small. The coronoid is large and subtriangular, and is overlapped from behind by the surangular on the external face of the ramus. Meckel's groove is closed. The columella auris is robust. The squamosal is present as a scale just above the quadrate.

The characterization of this family as given above has been extracted largely from Boulenger's[41] excellent definition, with minor additions of my own to make it conform to the fossil members here included. The characters that could be recognized only in the living amphisbaenians are omitted, only those parts relating to the osseous structure being cited.

The living Amphisbaenidae are legless (except *Chirotes*), worm-shaped lizards that lead an entirely subterranean, burrowing life, like earthworms. Their mode of progression is wormlike, their annulated soft skin enabling them to move backward as well as forward. The skull is small, compact, and strongly ossified in adaptation to their burrowing habit. The pectoral and pelvic arches are reduced to minute vestiges. The tail is short. In size they vary from 6 to 24 inches in length. Their food consists of small insects, especially ants, and worms. The American *Rhineüra floridana* emerges from its subterranean retreat after thunder showers; hence its vernacular name "thunderworm."

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[41] Catalogue of Lizards in the British Museum, 2d, ed., 1885, p. 430.

The Amphisbaenidae form a group comprising both recent and extinct representatives. The living forms inhabit the warmer parts of North and South America, the West Indies, Africa, and Mediterranean countries. (See fig. 16.) Extinct members of the family are now known from the Oligocene beds of Washington County, S. Dak.; Sioux County, Nebr.; Logan County, Colo.; the Middle Eocene of Uinta County and the Lower Eocene of Bighorn County, Wyo.

In 1885 Boulenger listed 65 species belonging to this family, but Dr. Leonhard Stejneger, who has a revision of the family in manuscript, informs me that there are in excess of 100 living species belonging to 30 or more genera.

The first information as to the origin of the Amphisbaenidae was given by Baur in 1893 when he announced the discovery of two new species in the Oligocene beds of South Dakota. The skulls described by him represented two genera, *Rhineüra*, an existing genus, and *Hyporhina*, an extinct genus. It is now known that Cope discovered specimens (*Platyrhachis*) pertaining to this family in the Oligocene of northeastern Colorado 20 years earlier, but their amphisbaenoid affinities were unrecognized until some years after Baur's announcement.

In 1919 Loomis described *Ototriton solidus* as a new genus and species of the Amphibia. This form is now recognized as belonging to the Amphisbaenidae and is the largest as well as the most ancient member of the family yet discovered.

The geological distribution of the extinct Amphisbaenidae is shown in the accompanying table.

Geologic distribution of the Amphisbaenidae

Period		Formation		Species
Oligocene		White River	Leptauchenia zone	*Rhineüra hatcherii.* *Hyporhina antiqua.*
			Oreodon zone	*Rhineüra hatcherii.*
			Titanotherium zone	*Rhineüra coloradoensis.*
Eocene	Upper	Uinta		
	Middle	Bridger	C	
			B	*Ototriton anceps.*
			A	
	Lower	Wasatch (Lysite beds)		*O. solidus.*

Hay[a] included the following genera and species under the family Amphisbaenidae:

Rhineüra hatcherii Baur.
Hyporhina antiqua Baur.
Tylosteus ornatus Leidy.
Aciprion formosum Cope.
Diacium quinquepedale Cope.
Cremastosaurus carinicollis Cope.
Platyrhachis rhambastes Cope.
Platyrhachis coloradoensis Cope.
Platyrhachis unipedalis Cope.
Naocephalus porrectus Cope.

In 1908 Nopcsa[42] reduced this list by the omission of *Tylosteus* (probably a dinosaurian reptile) and the removal of *Naocephalus* to the *incertae sedis* class, both changes with which I am in full accord. Of the remaining forms, only *Rhineüra hatcherii*, *Hyporhina antiqua*, and

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[a] Bull. U. S. Geol. Surv., no. 179, 1902, pp. 476, 477.

[42] Beitr. Pal. und Geol. Oester.-Ung., vol. 21, p. 49.

Rhineüra coloradoensis are now considered true members of the Amphisbaenidae; the other genera and species are either regarded as *incertae sedis* or have been given other family assignments.

At this time there is little to be said as to the origin of the Amphisbaenidae. Cope[43] says:

> No information as to the origin of the Amphisbaenidae or of the Annulati was accessible until Doctor Baur in 1893 announced the discovery of two species in the Oligocene beds of South Dakota, where skulls were found by Mr. J. B. Hatcher, of the Princeton exploring expedition. These cranii represent two genera, *Rhineüra* Cope, still existing, and *Hyporhina* Baur, extinct, and both are more nearly allied to *Lepidosternon* than to *Amphisbaena*. The species are termed *R. hatcherii* and *H. antiqua*.
>
> This interesting discovery explains the existence of *Rhineüra* in Florida, and relieves us of the necessity of supposing an immigration of Lepidosternoid reptiles from the South American Continent, a hypothesis which is the more difficult to sustain since there are no Amphisbaenidae in Mexico or the West Indies.

The family Amphisbaenidae is here regarded as including the following extinct genera and species:

Rhineüra hatcherii Baur.
Rhineüra coloradoensis (Cope.)
Hyporhina antiqua Baur.
Ototriton solidus Loomis.

Key to extinct genera of the family Amphisbaenidae

Postorbital arch absent; prefrontal entering into border of orbit. Single premaxillary tooth, five to six maxillary teeth. Small size.................... *Rhineüra.*
Postorbital arch absent; prefrontal entering into border of orbit; three teeth in premaxillary, seven maxillary teeth. Large size.................... *Ototriton.*
Postorbital arch present; prefrontal excluded from border of orbit. Four maxillary teeth. Small size. *Hyporhina.*

Genus RHINEÜRA Cope

Rhinüera Cope, E. D., Proc. Acad. Nat. Sci. Philadelphia, 1861, p. 75.

Genotype.—*Rhineüra floridana* (Baird).

Characters.—Nostril opening on the lower surface of the snout. Head depressed with broad, projecting snout with angular edge. Quadratum nearly perpendicular. Prefrontal entering into border of the orbit.

The genus *Rhineüra*, as applied to extinct forms, includes the two species *R. hatcherii* and *R. coloradoensis*. Stejenger and Barbour[44] include it under the family Leposternidae, but since the whole group is undergoing revision by Stejneger the genus will be retained for the present under the more widely used term Amphisbaenidae.

RHINEÜRA HATCHERII Baur

(Pl. 1, figs. 2, 2a, 3, 3a, 4)

Rhineüra hatcherii Baur, G., Amer. Nat., vol. 27, 1893, p. 998.—Cope, E. D., Rep. U. S. Nat. Mus., 1898 (1900); p. 684.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 476.—Eigenmann, C. H., Proc. Washington Acad. Sci., vol. 4, 1901, p. 534.—Douglass, Earl, Annals Carnegie Mus., vol. 4, 1908, pp. 283, 284, text Figs. 3, 4, 5.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 46.—Eigenmann, C. H. Pub. 104, Carnegie Inst. of Wahington, 1909. p. 48.—O'Harra, C. C., Bull. No. 9, South Dakota School of Mines, 1910, p. 121, Fig. 20; Bull. No. 13, South Dakota School of Mines, 1920, p. 160.—Zittel, K., and Broili-Schlosser, Gründezüge der Pal. (4th ed.), vol. 2, 1923, p. 257, Fig. 360.

Type specimen.—Princeton University, catalogue No. 11,389. Consists of an articulated skull and lower jaws. Collected by J. B. Hatcher, 1893.

Type locality.—Battle Draw Spring, Washington County, S. Dak.

Horizon.—Leptauchenia zone, "Uppermost" White River formation, Oligocene.[45]

Original description.—The larger skull, which measures 13 mm. from the middle portion of the condyle to the anterior end of the premaxillary and 5½ mm. at its transverse diameter between the posterior ends of the maxillaries, is so close to *Rhineüra* Cope, from Florida, that I am not able to place it with the present material in another genus.

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[43] Ann. Rep. Smithsonian Inst., 1898 (1900), p. 683.

[44] Check list of North American Amphibians and Reptiles, 1917, p. 72.

[45] Dr. W. J. Sinclair, after again visiting this locality, writes, under date of Sept. 29, 1922, as follows: "I can now offer a suggestion regarding the *Hyporhina-Rhineüra* locality and horizon. Battle Creek Draw (also called by some Nevis Creek) is a long draw immediately SW. of the various branches of Quinn Draw. Battle Cr. Canon is next to the SW. and then Cedar Draw, according to modern nomenclature. There is a good spring issuing from the wall of Cooney Table at the head of *Battle Creek Draw*. 'Uppermost' White R. Beds' at the spring would mean Leptauchenia zone. There are no Protoceras channels there, so far as we know, but the upper part of the cliff boundary, the table is Leptauchenia ash beds."

> The nostrils are inferior in position. The single premaxillary is widely separated from the frontals by the large nasals, which are distinct and extend to the nostrils. The prefrontal is large, placed between parietal, frontal, and maxillary, forming the superior border of the orbit; the jugal is exceedingly rudimentary, only connected with the maxillary; there is in all living Amphisbaenians no postorbital arch. The squamosal is not free. One tooth on premaxillary, six pointed teeth on each maxillary. It is distinguished from the modern *Rhineüra floridana* Baird by the more slender form of the skull, and may be called "*Rhineüra hatcherii.*"

This brief original account constitutes all that has ever been published descriptive of this species. In 1908 three illustrations of the skull and mandible, showing lateral, dorsal, and ventral aspects, based on materials in the Carnegie Museum, were published by Douglass,[46] but without new descriptive matter. These figures of the *Rhineüra* skulls, however, are not to be relied on for structural details. The larger suite of specimens at my command, together with the more thorough preparation of the skulls, disclosing features not before visible, enables me to correct several errors and to add many details to these first illustrations. While the complete structural detail of the skull is not yet known, the present study has considerably advanced our understanding of this previously little known amphisbaenian.

The type of *Rhineüra hatcherii* Baur consists of a well-preserved skull and articulated lower jaws, and fortunately of such development that many of the sutures can be clearly observed. The anterior border of the premaxillary and a portion of the right posterior side of the brain case are the only important parts missing. In the materials assembled for this study are five other skulls, two of which are practically complete, and from a study of all it has been possible to determine with accuracy most of the constitutent elements of all aspects of the cranium.

Although the species was described some 32 years ago, the type specimen is here illustrated for the first time. (See pl. 1, figs. 2, 2a.)

SKULL

The skull is small, compact, and strongly ossified, devoid of postorbital and postfrontal-squamosal arches and epipterygoid. The teeth are pleurodont, and in all of these respects it is precisely like the living North American species *R. floridana* (Baird).

From the middle of the condyle to the anterior end of the premaxillary, the type skull measures 12.5 mm.; its complete length is estimated to have been about 15 mm.; its greatest width 5 mm.

Superior aspect.—The parietal is large, forming the superior covering for the greater part of the posterior half of the skull. At the center it rises to form a decided median sagittal crest. Posteriorly this crest is deeply and narrowly emarginate and receives the slender, wedge-shaped superior termination of the supraoccipital. (See fig. 2a, pl. 1.) Forward of the middle of this bone the two borders of the crest diverge and this point marks a change in the character of the surface of the bone from a smooth to a roughened grooved surface that continues forward over all of the bones, forming the top of the anterior region of the skull. The median anterior end of the parietal in specimen No. 423B, Carnegie Museum, is V-shaped, the point extending forward between the frontals which are flanked on either side by the long, narrow extensions of the parietal that meet the prefrontal by a straight transverse suture above the center of the orbit. The union of these two bones is not clearly shown in the type, but in Nos. 423A and 423B, Carnegie Museum, and 12226, American Museum of Natural History, the sutures stand out very distinctly and the text illustrations have been drawn on the evidence of these specimens.

Posteriorly the parietal, by a long overlap, covers the elements which form the occipital portion of the skull, but which I am unable from the present materials to differentiate in detail. Much of the posterior portion of the parietal is missing in the type, but in No. 423A, Carnegie Museum, its entire extent is determined, as shown in Figure 17. Laterally the parietal joins the squamosal, proötic, alisphenoid(?), and probably the orbitosphenoid, though the latter bone has not certainly been recognized as a separate element. There is no pineal foramen in the parietal. The paired frontals are wide, deeply and widely emarginate on the anterior borders for the nasals, their short lateral extensions projecting well forward between the maxillary and nasals, as shown in Figure 2a, Plate 1.

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[46] Annals Carnegie Museum, vol. 4, 1908, pp. 283, 284, figs. 3, 4, 5.

The nasals are distinct and contribute to the border of the muzzle where they roof over the nares, being wedged in between the premaxillary and maxillary. (See fig. 2a, pl. 1.)

The premaxillary is single with a very short alveolar surface that supports a single median tooth. In No. 423A, Carnegie Museum, the only skull having the premaxillary border completely preserved, this bone is shown to be broader than long. On the superior surface there are two elongated, longitudinal pits, separated by a median ridge, but these pits do not perforate the bone, as Douglass's figure would appear to indicate.[47]

Viewed from below, the premaxillary is transversely constricted at the middle of its length. The slender anterior ends of the maxillaries appear to entirely separate this bone from participation in the medial boundary of the narial openings. More anteriorly the bone expands, sending out slender lateral processes that extend in over and in front of the nasal contribution to the boundary of the narial openings.

Lateral aspect.—The *prefrontals* are narrow and form the forward border of the orbit. Posteriorly this bone is in narrow contact with the parietal, internally with the frontal, and anteriorly with the maxillary; ventrally with the palatines and ectopterygoid.

The *maxillary*, seen from the side, is a triangular bone that unites above with the prefrontal, frontal, and nasal, the posterior border being cut out to form the lower anterior border of the orbit. From a lateral view, on the posterior extremity of the maxillary, is what appears to be a small triangular bone, as in the living *R. floridana*, which Cope[48] suggested to be a jugal or lachrymal. Its position in relation to the maxillary suggests to me that it may be the outer extremity of the ectopterygoid, and not a distinct element. This bone is most distinctly shown on the left side of specimen No. 423A, Carnegie Museum, and apparently is continuous with the main part of the ectopterygoid bone. A row of small foramina extends along immediately above but parallel with the alveolar border. On the alveolar border there are six sharply pointed teeth. On the palatal surface of the maxillary a shelf of bone extends inward from the teeth in which are shallow concave depressions (see fig. 3a, pl. 1), probably for the reception of the teeth of the lower jaw, which bite inside the upper series. In this view the anterior end of the maxillary is in contact with the vomer, the nasals, and premaxillary; posteriorly with the ectopterygoid and palatine bones.

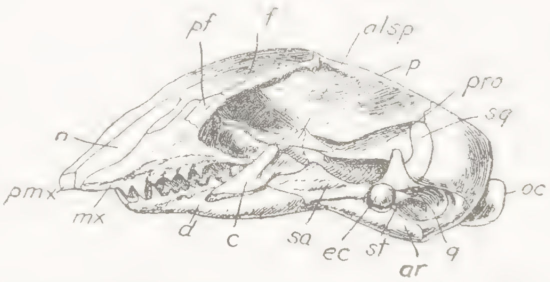

FIG. 17.—Skull of *Rhineüra hatcherii* Baur (No. 423A, Carnegie Museum), viewed from the left side. About four times natural size. *alsp*, alisphenoid; *ar*, articular; *c*, coronoid; *d*, dentary; *ec*, extra columella; *f*, frontal; *mx*, maxillary; *n*, nasal; *oc*, occipital condyle; *p*, parietal; *pf*, prefrontal; *pmx*, premaxillary; *pro*, proötic; *q*, quadrate; *sa*, surangular; *sq*, squamosal; *st*, stapes

As in all Amphisbaenidae, *Rhineüra hatcherii* has the brain case extending well forward and completely inclosed laterally by bone, in both respects resembling the ophidian cranium. Specimen No. 423C, Carnegie Museum, consisting of the posterior portion of the skull and the entire brain case (see fig. 4, pl. 1), being devoid of all external structures, shows quite clearly the composition of the lateral and ventral aspects of the skull.

In *Rhineüra floridana*, the lateral walls are formed by two bones, the anterior one Cope calls the alisphenoid, the other the petrosal. These bones join by a vertical suture above the center of the fissure separating them from the pterygoids and presphenoid, except for a slender pointed process that extends forward from the petrosal or proötic, underlapping the inferior posterior border of the alisphenoid. In *R. hatcherii*, the lateral walls likewise consist of two bones but their union presents a tapering, pointed extremity that is received between upper and lower anterior projecting processes of the proötic. (See fig. 17.) In skull No. 423A, Carnegie Museum, the proötic sends a process upward and backward between the parietal and squamosal. Posterior to the fissure, which in part at least must represent the trigeminal foramen, the proötic extends downward to meet the basisphenoid, thus filling the interspace between the foramen ovale and the large fenestra ovalis. At a point midway between these two large openings the proötic is perforated by a small foramen, probably the exit of the seventh cranial nerve. In the articulated skull this portion lies behind the quadrate.

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[47] Annals Carnegie Mus., vol. 3, 1908, p. 284, fig. 4.

[48] Proc. Amer. Philos. Soc., vol. 30, 1892, p. 217.

In skull No. 423A, Carnegie Museum, the fenestra ovalis is tightly closed on the left side by the expanded disk of the stapes which is continued externally as a rodlike *columella auris*. This is relatively short and terminated by a clublike end which articulates with a short, thickened bone that probably represents the extra-columella, being homologous with the epistapedial cartilage of other lacertilians. This is not shown in Douglass's illustration, since at that time it was covered by matrix.

Cope, in his detailed study of the skull of *Rhineüra floridana*, regarded the small bone which gives the chief support to the quadrate and here designated *squamosal*, as being "a prolongation of the exoccipital [paroccipital]." Since the paroccipital, in most reptilian skulls, is fully fused with the exoccipital and hardly ever recognizable as a distinct element, and also since the relationships of this element to the quadrate, parietal, and exoccipital bones is typically that of the squamosal in many other lizards, there would seem to be little doubt of its correct identification as used here.

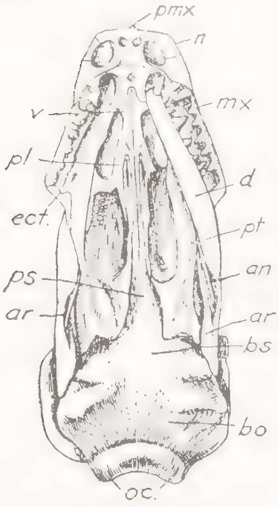

FIG. 18.—Skull of *Rhineüra hatcherii* Baur (No. 423A, Carnegie Museum), viewed from below. About four times natural size. *ar*, articular; *an*, angular; *bo*, basioccipital; *bs*, basisphenoid; *d*, dentary; *ect*, ectopterygoid; *mx*, maxillary; *n*, nasal; *oc*, occipital condyle; *pl*, palatine; *pmx*; premaxillary; *ps*, presphenoid; *pt*, pterygoid; *v*, vomer

After a careful review of the evidence, Camp [49] reaches the conclusion that the single element present in those lizards in which the supratemporal arch is absent should be considered the tabulare. It may be, therefore, that in *Rhineüra* the element here designated the squamosal is the tabulare. According to Camp the tabulare is questionably present in *Lepidosternon* and *Blanus cinerea*, but absent in *Agamodon* and in *Amphisbaena alba*. The early fusion of this bone probably accounts for the uncertainty and lack of recognition in many forms.

A skull of a young *Rhineüra floridana* (No. 32,270, U. S. National Museum) now before me, shows the squamosal as a distinct element to be a narrow, scalelike bone that extends upward and backward from its articulation with the quadrate and wedged in between the parietal, proötic, and exoccipital. The type of *R. hatcherii* exhibits a trace of the sutures separating this bone from the contiguous elements, but in all of the other skulls of this fossil species, they have become wholly obliterated. In *Hyporhina antiqua*, where the squamosal persists as a distinct element, its upward extension above the quadrate is much wider fore and aft than in the living *Rhineüra floridana*, and more extensive still in the Eocene *Ototriton*. In Figures 17 and 18 I have restored this region of the skull on the basis of the slight evidence shown in the type skull. The quadrate is short, stout, and, as in *R. floridana*, has no posterior proximal process. It is oblique proximally, but becomes nearly vertical distally when viewed from the side. The slightly expanded proximal end articulates with the over-hanging squamosal, which covers the whole top except a small spurlike process that projects upward in front and above the main articulation of these two bones. This projecting spur is much narrower antero posteriorly than in *R. floridana*. On the internal side at the proximal end it rests against and slightly under the upper portion of the proötic. The club-shaped head of the *columella auris* rests in the posterior angle of the quadrate, and the extra columella against its outer side in the one skull in which these elements are present. (See fig. 3, pl. 1.)

Ventral aspect.—In *Rhineüra* and the Amphisbaenidae in general the palate is much more compact than in other lizards. While the general relationships of the various bones of the palate in *R. hatcherii* are quite certainly determined, their exact extent, I am sorry to say, is not so definitely known. A comparison of the palatal view of *R. hatcherii* with *R. floridana*, as determined by Cope (compare figs. 18 and 19B), shows important structural differences, but I believe these differences are largely due to lack of detailed knowledge of the palate of *R. floridana.* A skull of the latter species now before me agrees in the main with Cope's illustrations, but I am inclined to the belief that the palatal sutures in the living form fuse much earlier than in the extinct species, and on that account many of the sutural contacts become obliterated so that the exact extent of certain elements can not be fully determined. Reference is made especially to the noninterposition of the palatines between the vomers and pterygoids in Cope's illustration of the palate in *R. floridana* (fig. 19B), whereas, as plainly shown in specimen No. 423A, Carnegie Museum, the palatines occupy their usual position between these elements.

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[49] Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, pp. 350, 351.

The large, scalelike pterygoid extends posteriorly as far as the distal end of the quadrate and appears to be in contact with it. The posterior end abuts against a heavy descending buttress of the basisphenoid, as shown in Figure 4, Plate 1, from specimen No. 423C, Carnegie Museum, having the pterygoid bones detached. The pterygoids are closely appressed to the sphenoidal bones; anteriorly they are bifurcated, sending one process inward and forward to join the palatine, while a second process extends forward and outward to meet the ectopterygoid and probably the palatine, although I am unable to determine the exact posterior extent of the latter element in any of the specimens now available. The vomers appear to continue backward between the palatine processes previously mentioned, their posterior ends slightly separated on the median line and terminating each in an acuminate end lying on the presphenoid. The forward end of the palatine process is received in a notch in the vomer, as is clearly shown in Figure 18 drawn from specimen No. 423A, Carnegie Museum.

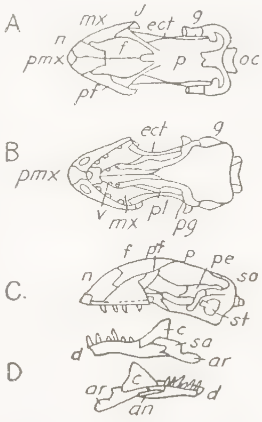

FIG. 19.—Skull of *Rhineüra floridana* Baird. About three times natural size. A, top; B, palatal; C, side; D, inner and outer views of mandible. *an*, angular; *ar*, articular; *c*, coronoid; *d*, dentary; *ect*, ectopterygoid; *f*, frontal; *j*, jugal; *mx*, maxillary; *n*, nasal; *oc*, occipital condyle; *p*, parietal; *pf*, prefrontal; *pmx*, premaxillary; *pl*, palatine; *pe*, proötic; *q*, quadrate; *sa*, surangular; *st*, stapes; *so*, supraoccipital; *v*, vomer. (After Cope)

At the anterior ends the combined vomers present a spear-shaped body that is received in a notch in the posterior border of the premaxillary, being only slightly in contact with the maxillae. The presphenoid, basisphenoid, and basioccipital are completely coossified in all of the skulls examined. The occipital condyle is simple, wide transversely, and broadly concave in the same direction.

The narrow, splintlike ectopterygoid extends forward from the outer branch of the pterygoid, turning outward on the posterior end of the maxillary, its outer extremity being visible from a lateral view of the skull. It was considered by Cope to be a separate element which he regarded as a remnant of either jugal or lachrymal.

The occipital segment of the skull is firmly and completely coossified in all of the available skulls of *Rhineüra hatcherii,* and therefore the bones of this region can only be differentiated in a general way. The exoccipital sends a process outward and forward, the paroccipital, which gives support to the squamosal and possibly is in contact with the quadrate. The exoccipital is perforated by a foramen that lies in a deep vertical depression immediately lateral to the foramen magnum, representing the outlet of the twelfth, or hypoglossal nerve.

The teeth are simple, conic, there being six in the maxillary with a single tooth on the premaxillary, and seven on the dentary. The manner in which the teeth are ankylosed to the top and inner side of the jaws would appear to place them intermediate between pleurodont and acrodont methods of attachment.

Professor Eigenmann[50] has called attention to the degeneracy of the eye in *Rhineüra floridana,* but nothing is known with regard to the eyes of the extinct forms. It seems practically certain, however, that the degeneration of the eyes took place before the differentiation of the existing genera. In the living forms there is no indication of the aperture by which the optic nerve entered the brain case, and this condition apparently prevailed in the extinct species.

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[50] Proc. Washington Acad. Sci., vol. 4, 1908, pp. 283–284.

Measurements of skulls of Rhineüra hatcherii

	No. 11389 Princeton Museum (type)	No. 423A, Carnegie Museum	No. 423B, Carnegie Museum	No. 12226 American Museum Natural History	No. 423C, Carnegie Museum
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*
Greatest length at center	[a] 13. 5	15. 0	[a] 15. 0	[a] 15. 0	----------
Greatest width across squamosals	5. 7	6. 4	6. 4	6. 5	6. 5
Greatest width between orbits	4. 0	4. 5	4. 4	----------	----------
Least width of brain case	3. 2	3. 7	3. 8	3. 7	----------
Greatest transverse diameter of occipital condyle	2. 8	3. 0	3. 0	3. 0	3. 5

[a] Estimated.

LOWER JAW

The mandible of *Rhineüra hatcherii* consists of the dentary, coronoid, articular, splenial, surangular, and angular. There is no trace of the Meckelian groove. In two specimens, Nos. 423A and 423B, Carnegie Museum, the dentary carries seven teeth; the number in the type could not be determined because of adhering matrix which could not be removed without great danger of permanent injury to the specimen. The symphysial end of the dentary turns inward slightly to meet its fellow of the opposite side, the two forming a moderately broad, rounded mandible that bites within the upper dental series. The dentaries have a ligamentous union. Posteriorly the dentary overlaps the coalesced articular and surangular, terminating in a pointed end back of the coronoid. The articular and surangular send a pointed process forward over the superior end of the dentary, which is wedged in between it and the coronoid.

The postcoronoidal part of the ramus is relatively long, nearly equaling the precoronoidal part, a feature that will serve to distinguish this species from *R. floridana* in which the precoronoidal exceeds considerably the postcoronoidal portion. The cotylus for the reception of the quadrate is deep. In the articulated specimens the articular is produced backward of the cotylus, terminating as a bluntly tapered end that reaches the posterior border of the fenestra ovalis. Some of the modern amphisbaenians, as *Agamodon*, *Monopeltis*, and *Amphisbænia*, have no posterior extension of the mandible beyond the cotylus, but whether this lengthening of the postcoronoidal portion of the mandible is a feature distinctive of the genera *Rhineüra* and *Hyporhina* I am unable to fully determine.

The coronoid is large, triangular, and stands high above the upper border of the ramus, its upper extremity slightly inclined backward. Anteriorly it extends well forward on the dentary, its anterior extremity being in advance of the most posterior tooth. In this respect it differs from *R. floridana* where it does not reach the last tooth. Externally its posterior extremity rests upon the pointed anterior extremity of the surangular.

The angular is short, with a narrow posterior portion that is barely visible from a lateral view. Viewed ventro-internally it passes diagonally across the ventral border of the surangular to the internal side of the ramus, widening dorso-ventrally into a flattened splintlike bone that is closely applied to the dentary and terminates slightly in advance of the coronoid; above it is in contact with the small, narrow splenial. The full extent and shape of the splenial can not be determined from the available material.

The greatest length of the ramus in the type is 8.75 millimeters; in No. 423A, Carnegie Museum, it measures 10 millimeters; in the latter the seven teeth occupy a space of 4.5 millimeters.

ATLAS AND AXIS

Among the specimens received from Princeton University is an occipital portion of a skull of *Rhineüra* (No. 11391) with which five vertebrae were associated. Nothing is known of the association of these bones in the field except that on the list transmitted with the specimens is recorded "base of skull and scattered vertebrae." Four of these prove to be ophidian, referable to *Calmagras murivorus* Cope. That the remaining atlas intercentrum which is coossified with the centrum of the axis belong to the same individual as the base of the skull there is no positive evidence, and this uncertainty is further emphasized by comparison with an articulated specimen of *Rhineüra floridana* which apparently shows that the fossil atlas and axis are too large for the condyle of the associated skull, though its wide, transversely convex anterior end is well adapted to the peculiar wide, concave articulating surfaces of the condyle, a form that is apparently peculiar to the Amphisbaenidae. Although in detail there are differences on the ventral surfaces of this and the corresponding parts of *R. floridana,* the general resemblance is remarkably similar. The skull portion is quite certainly identified as *R. hatcherii.*

The intercentrum of the atlas is closely coossified to the centrum of the axis, though their union is still plain on the sides, but below is completely obliterated. On this account they will be described as a single bone.

The neuropophyses are missing from both. Viewed from below, the intercentrum part of this complex forms a conspicuously broad, crescent-shaped anterior end having a flat ventral surface. It presents a broad, regularly rounded end. The second vertebra has a strong, bifurcated keel-like hypophysis as shown in Plate 25, Figure 9. The articulating end for the occipital condyle is strongly convex from side to side, and concave dorso-ventrally. This articular surface vertically is about evenly divided between the atlas intercentrum and the odontoid process of the axis. The sutural outlines of the odontoid are clearly visible except on the dorsal surface. Transversely the odontoid is only about one-half as wide as the inferior intercentrum. Dorsally the floor of the neural canal of the axis is excavated by two longitudinal depressions that are separated by a median ridge of bone. The ball is wider than high and projects posteriorly in nearly the same plane as the longer diameter of the centrum.

Measurements of atlas and axis, No. 11391, Princeton Museum

	Mm.
Greatest length of coossified elements	5. 25
Greatest transverse width of intercentrum of atlas	4. 75
Greatest width of odontoid process	3. 50
Greatest transverse width of ball of axis	2. 70
Greatest height of ball of axis	2. 00

SUMMARY

The characters in the skull which appear to distinguish *Rhineüra hatcherii* from the type species of the genus, *R. floridana,* may be summarized as follows: Skull with sagittal crest; maxillary teeth, 6–6; mandibular teeth, 7–7; coronoid extending forward of last tooth of mandibular series; postcoronoid portion of mandible about equal in length to precoronoid part.

Rhineüra hatcherii has its closest affinities with the living *R. floridana,* as shown by the close resemblance in arrangement and extent of the various elements of the skulls. While this study of all known materials has disclosed differences, none could be regarded as having more than specific value, all the more remarkable when the Oligocene age of the extinct species is taken into consideration. Baur, in his original description, distinguished the two species by the "more slender skull" of the fossil form, a difference that I fail to find, as the relative proportions of extant and extinct species of the genus appear identical.

REFERRED SPECIMENS

In addition to the type, the following specimens were available for this study:

No. 423A, Carnegie Museum, a skull and articulated lower jaws; No. 423B, Carnegie Museum, skull and articulated left ramus; and No. 423C, Carnegie Museum, complete brain case. Oligocene, "Oreodon beds," on Badland Creek, Sioux County, Nebr. Collected by O. A. Peterson, 1901.

No. 11391, Princeton University. Occipital portion of skull, atlas, axis. Oligocene, "Uppermost White River beds," Leptauchenia zone, Battle Draw Springs, S. Dak. Collected by J. B. Hatcher, 1893.

No. 12226, American Museum of Natural History. Considerable portion of skull and right ramus. Lower Oreodon beds, White River, Oligocene, Cedar Draw, Cheyenne River, Washington County, S. Dak. Collected by Albert Thompson, 1904.

No. 10961, United States National Museum. Three dorsal vertebrae. White River, Oligocene, Hat Creek Basin, Sioux County, Nebr. Collected by J. B. Hatcher, April 18, 1888.

RHINEÜRA COLORADOENSIS (Cope)

(Pl. 25, figs. 10, 11, 12)

Platyrhachis coloradoensis Cope, E. D., Synop. new Vertebrata from Tertiary of Colòrado, Washington, October, 1873, p. 19; Ann. Rep. Geol. and Geogr. Surv. Terr. for 1873, 1874, p. 516; Rep. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 778, pl. 60, fig. 17.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 477.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.—Ung., vol. 21, 1908, p. 44 (as *P. coloradensis*).

Type specimen.—American Museum of Natural History, catalogue No. 1607. Consists of three and one-half articulated median dorsal vertebrae. Collected by E. D. Cope, 1873.

Type locality.—Horse Tail Creek, Logan County, Colo.

Horizon.—Horse Tail Creek beds,[51] White River formation, Oligocene.

Original description—Char. gen.—Dorsal vertebrae united by the zygosphene, as well as the usual articulation. Centrum much depressed, flat below. Neural arch depressed, an angle connecting the zygosphenes. Neural spines a keel, projecting beyond the posterior magrin in a mucro.

Character specification.—Ball truncate below its convex face, looking slightly upward. Costal capitular surface semiglobular directly below the anterior zygapophysis. Neural arch concave between the zygapophyses.

Measurements

	M.
Length of three dorsal vertebrae	0.0070
Length of one dorsal vertebra	.0028
Diameter of ball:	
Transverse	.0014
Vertical	.0006
Elevation of vertebra	.0019
Width between zygapophyses	.0025

The size of this species is similar to that of the two species already described from teeth; but the vertical articulation is not appropriate to *Exostinus* with existing lights.

The above adequately describes the type except that there is no zygosphenal articulation of the vertebrae, a fact recognized later by Cope.[52]

> The genus [*Platyrhachis*] was founded on the supposition that the typical species, the *P. coloradoensis*, possesses the zygosphene articulation, a character which I have since been unable to verify, and do not now believe in.
>
> The subtraction of this character leaves little for the genus to stand on; but I retain the name with the following definition.
>
> Vertebral centra with the articular faces much depressed, and without inferior or lateral carinae. The ridge connecting the zygapophyses deeply incised. Neural spine a low keel.

I have carefully compared these vertebrae with the median dorsals of *Rhineüra floridana* and find such close similarities as to leave no doubt of their near affinities. I shall, therefore, refer this species provisionally to the genus *Rhineüra*, although it is quite possible that it may be cospecific with *R. hatcherii*, in which event the last named species would become a synonym of *R. coloradoensis*, which has priority by 20 years. Since vertebrae of *R. hatcherii* are not certainly known, and also since that species has not yet been recognized in the Colorado locality, it would appear best for the present to continue the use of both species until the discovery of associated skull and vertebral materials will definitely determine the true status of these vertebrae.

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[51] "Titanotherium beds; horizon A of Hayden and Leidy." W. D. Matthew, Mem. Amer. Mus. Nat. Hist., vol. 1, 1898, p. 356.

[52] Rep. Geol. Surv. Terr., vol. 3, 1884, p. 778.

A second specimen, tentatively regarded as pertaining to the present species is included in the lizard material belonging to the American Museum of Natural History. This specimen, No. 989, consisting of an articulated series of 19 vertebrae (see pl. 25, figs. 11, 12) is labeled as coming from the White River formation of Colorado. Except for being one-third larger, it closely resembles, in all particulars, the type of the species. The first vertebra of the series has a sharp, keel-like hypophysis which diminishes progressively on the second and third, and which is no longer perceptible on the fourth. In *Rhineüra floridana* this keel is first absent on the sixth. If a similar condition prevails in the extinct species, the most anterior vertebra of the series would be the third cervical or the first one posterior to the axis. In *R. floridana* the third cervical vertebra carries the first rib, and in the specimen now before me there are well developed costal capitular processes (see pl. 25, fig. 12) that stand out from the side of the centrum directly below the anterior zygapophyses, more prominently than on any of the succeeding members of the vertebral column. These become successively shortened on the two succeeding vertebrae, the fourth having only a semiglobular costal surface that continues backward with but little change throughout the remainder of the series. The ventral surfaces of the centra posterior to the third are flat, with neural arch deeply incised between the anterior and posterior zygapophyses. Paired subcentral foramina occasionally present, sometimes only one, and in many other vertebrae both are absent. The posterior portions of the short, keel-like neural spines are broken away on all of the vertebrae, though there is reason to believe their termination was low and pointed, and overhung the posterior end of the centrum as in *R. floridana*. The 19 vertebrae have a total length of about 65 mm.

Genus OTOTRITON Loomis

Ototriton Loomis, Amer. Journ. Sci., vol. 47, 1919, pp. 217-219.

Genotype.—Ototriton solidus Loomis.

A little known genus from the Lower Eocene of Wyoming. It is not altogether certain that *Ototriton* is a valid genus, but I propose to retain it in the expectation that better specimens will be discovered which will make possible the determination of its true affinities. Its large size and ancient geological occurrence appear to justify this course. The affinities of the genus are closer to *Rhineüra* than to *Hyporhina*. Two species, *Ototriton solidus* and *O. anceps* (Marsh) are recognized.

OTOTRITON SOLIDUS Loomis

Ototriton solidus Loomis, Amer. Journ. Sci., vol. 47, 1919, pp. 217-219, text fig. 1.

Type specimen.—Amherst College, catalogue No. 04–22. Consists of a fairly complete skull and fragmentary portion of the left ramus. Collected by Amherst expedition of 1905.

Type locality.—Bridger Creek, Big Horn County, Wyo.

Horizon.—Lysite beds, Wasatch, Lower Eocene.

Original description.—Among the specimens collected from the Lysite beds of the Lower Eocene on Bridger Creek, Wyo., by the Amherst College expedition of 1905, is a well preserved skull of an amphibian. It is about 1¼ inches long and represents an individual about the size of a mud puppy (*Necturus*). Though amphibians must have lived in the ponds and moist places then, as both before and since Eocene time, I believe none has heretofore been found. The Lysite represents flood-plain deposits, under a rather arid climate, as do most of our western Eocene epicontinental deposits, but there must have been streams and moist places, and this form presumably lived in or near some such place.

Unlike such amphibian remains as have been found in the Tertiary, this skull can not be referred to any of the living genera, though it seems to be clearly one of the Caudata, and belongs to the family Salamandrioae, and be as near to the genus *Triton* as to any of the living types; but it differs in so many material points that I am not by any means confident that it can be considered in any way ancestral. It is peculiar among all amphibians in having a small splintlike supraoccipital bone, and among caudate types in having a trace of the parietal foramen, though the actual opening is closed and plugged with bone. The anterior part of the skull is fused into a solid roof, and I can not see where the nasal passages opened anteriorly, though the interior openings are large. The cartilage bones of the posterior part of the skull are unusually completely ossified, and the otic region is developed so as to form a strong projecting process on the ventral side. Most of the skull is preserved except the quadrate region, and parts of the squamosum and pterygoid bones.

> I have called the form *Ototriton solidus* gen. et sp. nov. The type is in the Amherst College cabinet, and comes from Bridger Creek, Wyo., from the Lysite beds, associated with *Eohippus kraspidotus, Phenacodus vortmani, Notharctus ventricolus, Paramys bicuspis*, etc.
>
> The frontals and nasals of both sides are fused together and to the maxillae; so that the whole anterior part of the skull is solidly roofed over. The premaxillae, however, were free and must have been small. They are lacking, but along the front of the skull are grooves into which they set. * * * In this respect, but in no other, the skull suggests *Necturus*. The parietals extend back from the frontals to the rear of the cranium. (The line cutting off the rear part of the parietals is not a suture but a crack.) These bones are paired, and along the middle line in the rear, separated from each other by the narrow splintlike supraoccipital bone; most unusual in amphibians, but very clear here. Near the front of the parietals is a depressed area, in which there is an oval groove which can represent nothing but a parietal foramen, though it is closed and plugged with bone; but very clearly outlined, especially when magnified. Along their posterior border the parietals flare up a little making a low crest across the rear of the skull. The proximal end of the squamosum bone is present but that is all.
>
> The maxillae carry a row of simple conical teeth set along the outer margin (acrodont); and probably extended onto the premaxillae, which are lacking though indicated. Inside these are several tiny teeth indicating a second inner row of much smaller size. The palate is strongly arched for an amphibian, its anterior portion being roofed by the vomers, each of which has a tiny tooth on the front margin. On the posterior border of the vomers, open the posterior choanen; and from this point back the palate is even more arched. The palatal bones are strongly arched and unusually wide, extending back in this specimen to beyond the middle of the skull; and possibly the pointed rear ends are missing. The arrangement of the vomers, palatines, and the choanen is most like that of the newts, especially in the extended palatals, in the development of the choanen, and in the arching of the palate. Still it is not close enough to Triton so that I would want to put it in the same genus. The parasphenoid is of moderate size, and it tends to be confluent with the exoccipitals and otic bones, but faint suture lines indicate the boundaries I have shown in Figure 1B. The back part of one of the pterygoids is present and this is separate from the palatal bones entirely.
>
> The two occipital condyles are confluent and completely ossified, making a saddlelike articulation for the skull. The whole otic region is completely ossified and strongly developed. The inner ear chamber has inflated the otic bones so that they have developed a stout process around it, on the out end of which is the stapes, wholly ossified, and in place on the left side, though lost on the right. The epiotic also is largely inflated and develops into strong lateral knobs from which the squamosum starts.
>
> The back end of the lower jaw is present and of typical caudate pattern, but there is not enough of it to offer any basis for comparisons.

That the above described form might be lacertilian was first brought to my attention by Dr. E. R. Dunn of Smith College, who, at the same time, suggested its possible affinities with the amphisbaenoid lizards, a conclusion now fully confirmed by a comparison of the type specimen with the other extinct members of the Amphisbaenidae.

When the skull was received for my study, it was found that many of its detailed features were obscured by adhering matrix. Further preparation and a final etching with acid revealed a few of the sutures and other details which were not visible to Loomis when he studied it. The thick, strongly ossified character of the whole structure of the cranium; absence of fronto-squamosal and postorbital arches; reduced number of acrodont teeth; premaxillary bearing an odd number of teeth (three); coronoid large and subtriangular in form; and many other lesser features in common with known amphisbaenians, clearly indicate its affinities.

The skull of *Ototriton* probably exceeds in size that of any known extinct member of the family. Measured from the middle of the occipital condyle to the anterior end of the premaxillary it has a greatest length of 31.5 millimeters, and a greatest width of 23.5 millimeters. The upper anterior surface of the skull is much checked and fractured which makes it practically impossible to trace the cranial sutures. The posterior extremity of the right maxillary, both quadrates, right pterygoid and some of the left, are missing. The teeth are all lost except the bases of two in the left maxillary. The palatal region is in such an obscure condition that but little of its detailed structure can be determined.

Viewed laterally the skull is strongly arched from front to back as in *Rhineüra*. The muzzle, viewed from above, is intermediate in contour between the elongate *Rhineüra* and the broadly rounded *Hyporhina*, as may be seen by comparing Figures 18, 20, and 23. The brain case is relatively narrower than in either of the above mentioned genera. The parietal forms the roof for the greater portion of the posterior half of the skull and is continuous laterally with the alisphenoid, proötic, and squamosal bones. It is not perforated by a pineal foramen, further preparation showing that Loomis was in error regarding its presence. Posteriorly the upper extremity of the supraoccipital is received in a long, narrow cleft on the median line (see fig. 20), forward of which there is a distinct sagittal crest, which subsides into a transversely rounded surface before reaching the divergent anterior end of the parietal. Posteriorly the parietal laps over the occipital portion of the skull by a long squamous suture as in *Rhineüra*. The posterior termination of this bone is clear in the specimen, as shown in Figure 20, and is slightly in advance of the crack paralleling it, of which Loomis makes mention. The front parietal suture is plainly seen, as shown in Figure 20. On either side of the median extension between the frontals, the parietals send forward long, narrow, divergent processes that form the upper orbital border and articulate at their anterior terminations with the prefrontals at a point above the center of the orbit as in *Rhineüra*. These relations can be plainly distinguished under the glass on the left side but I am unable to differentiate the sutures of the opposite side. The extent of the frontals can not be certainly determined. The upper surface of the entire anterior portion of the skull is roughened by pits and irregular grooving, but no attempt has been made to depict this sculpturing owing to the obscurity of the pattern due to the checking and cracking of the entire surface. The nasals are paired and, as in the other extinct forms, contribute to the border of the muzzle where they roof over the nares.

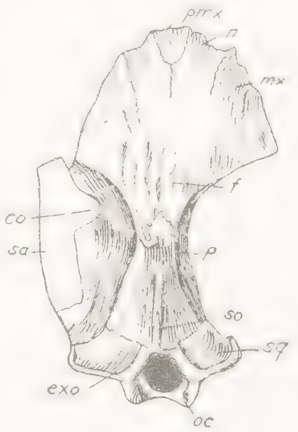

FIG. 20.—Skull of *Ototriton solidus* Loomis. Type. (No. 04–22, Amherst College.) One and one-half times natural size. Upper view. *co*, coronoid; *exo*, exoccipital; *f*, frontal; *mx*, maxillary; *n*, nasal; *oc*, occipital condyle; *p*, parietal; *pmx*, premaxillary; *sa*, surangular; *so*, supraoccipital; *sq*, squamosal

The premaxillary is completely preserved. It is comparatively small with a short alveolar border and seems to support three teeth—a large median one flanked on either side by a minute one. The uncertainty concerning their presence is due to the loss of the teeth themselves, but three cupped depressions apparently indicate the seats wherein they were attached. (See fig. 21.) An equal number of premaxillary teeth are found in the living African *Geocalamus* and *Agamodon* and in the South American *Lepidosternon boettgeri*. Viewed from below the premaxillary is contracted a little by a process of the maxillary which enters from the alveolar portion separating it from the nares. Posteriorly on the palatal surface this bone is expanded transversely and meets the enlarged anterior ends of the vomers, as shown in Figure 21.

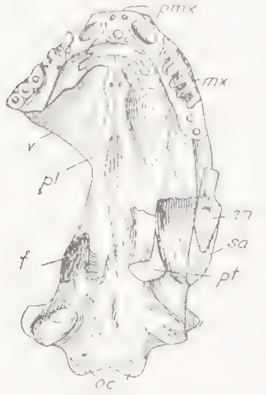

FIG. 21.—Skull of *Ototriton solidus* Loomis. Type. (No. 04–22 Amherst College.) One and one-half times natural size. Lower view. *an*, angular; *f*, foramen ovale; *mx*, maxillary; *oc*, occipital condyle; *pl*, palatine; *pmx*, premaxillary; *pt*, pterygoid; *sa*, surangular; *v*, vomer

The maxillae carry a row of teeth set along the outer border, probably seven in number. They are subpleurodont in their method of attachment. All are missing except the basal portions of two in the left maxillary. I fail to find any trace of the "several tiny teeth" said by Loomis to form a "second inner row of much smaller size."

The squamosal of the right side is a thin, scale-like bone that has a much greater extent than originally depicted by Loomis. On this side of the skull much of this element has scaled off and is lost, but a shallow depression in the underlying bone appears to indicate its full extent and that it was in contact with the parietal on its upper anterior border. The ventral border is thickened transversely and furnishes the main articulation for the quadrate. The lateral elements of the brain case can not be differentiated. The foramen ovale is large and ovate as in *Rhineüra;* the fenestra ovale lies behind the quadrate and below the paroccipital process. It is large and probably closed by the disk of the stapes as in other amphisbaenians, but in this specimen both stapes are missing.

The occipital segment of the skull is completely coossified and offers but little information as to its composition. The occipital condyle is single, widened transversely, and medially concave. The condyle has a greatest transverse diameter of 7 millimeters.

The basioccipital, basisphenoid, and presphenoid are coossified. The palatal bones are strongly arched. The pterygoids are largely missing but that they were scale-like with the posterior end lying in a shallow depression on the sphenoidal bones is clearly shown on the right side of the palate. The ectopterygoid can not be differentiated. The basipterygoid processes are wide apart and especially robust and heavy. The palatines unite on the median line with the vomers by long slender processes that are received in notches in the vomer, as in *Rhineüra*. (See fig. 21.) The enlarged, pointed anterior extremities of the vomers enter a notch in the posterior border of the premaxillary. They are plain in front but become convex posteriorly. A portion of the left lower jaw is present and shows the complete coronoid as being large, subtriangular in outline, but there is not enough of the jaw to offer any basis for further comparisons.

Ototriton anceps (Marsh)

(Pl. 18, figs. 14, 15)

Glyptosaurus anceps Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 1, 1871, p. 458; Proc. Acad. Nat. Sci. Philadelphia, 1871, p. 105.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Douglass, Earl, Ann. Carnegie Mus., vol. 3, 1908, p. 283.—Nopcsa, F. B., Beitr. Pal. und. Geol. Oester.-Ung., vol. 21, 1908, p. 39.—Gilmore, C. W., Mem. Carnegie Mus., vol. 7, no. 2, 1917, p. 160.

Type specimen.—Yale University Museum, catalogue No. 520. Consists of a single dorsal vertebra. Collected by O. C. Marsh and C. T. Ballard, 1870.

Type locality.—Grizzly Buttes, Uinta County, Wyo.

Horizon.—Horizon B, Bridger formation, Middle Eocene.

Original description.—A small species of lizard, quite distinct from those described above, as indicated by numerous fragmentary remains found associated with them in the same deposits. Some of the characters exhibited by these specimens point toward a different genus, but until additional material is obtained, the species may appropriately be placed in *Glyptosaurus*. The vertebrae have the cup and ball equally transverse with those of the species already described, but they are much less inclined from the vertical. The neural arch is also less elevated in the specimen preserved and the whole vertebra is more depressed. The teeth are pleurodont. The species was about two feet in length.

Measurements

	Lines	
Length of posterior dorsal vertebra, from edge of cup to end of ball	2.8	[5.5 mm.]
Width of cup	2.0	[3.1 mm.]
Depth of cup	1.0	[2.0 mm.]
Expansion of anterior zygapophyses	4.3	[9.0 mm.]

A perusal of the above account leaves one in a very unsatisfactory frame of mind as to the exact materials available to Professor Marsh at the time of establishing this species. The type material, as it came into my hands, consisted of a single dorsal vertebra inclosed in a glass vial, on the stopper of which was plainly inscribed "(type) *G. anceps* G. Buttes, O. C. M. 1870." This vertebra agrees in every particular with the original description and measurements. A very careful search of the entire Yale collection of lacertilian remains has failed to disclose more than one other specimen which could be certainly referred to the present species, which therefore rests on the characters displayed by this single dorsal vertebra. When compared with thoracic vertebrae of *Glyptosaurus sylvestris*, as represented in the topotype, and those of the type specimen of *G. hillsi*, such striking dissimilarities are found as to show that it does not belong to the genus *Glyptosaurus*, a fact of which Marsh was apparently cognizant at the time.

The principal characters which definitely distinguish this vertebra from those of *Glyptosaurus* are the depressed and broad centrum, low neural arch apparently without neural spine, articular ball looking more forward than upward, anterior zygapophyses depressed, globular costal articulations that look more downward than outward. In all of these particulars this vertebra is in agreement with the dorsal vertebrae of the Amphisbaenidae; compare figures 22 and 23. That its affinities lie in this family is further emphasized by comparison with a specimen of *Rhineüra* (No. 989, American Museum of Natural History) with which it is in full accord in so far as the features mentioned above are concerned. Furthermore, on either side of the acute median ridge of the fossil vertebra, the superior surface is sculptured by a series of four or more prominent longitudinal ridges (see fig. 23) between which are shallow depressions having a width about equal to that of the ridges. A similar, though less distinct, sculpturing is observed on several of the vertebrae of the American Museum specimen mentioned above. Since similar sculpturing has not been observed on other lacertilian vertebrae, this feature lends additional support in favor of its amphisbaenoid affinities.

In view of the resemblances pointed out, I propose to remove this species from the genus *Glyptosaurus* and provisionally assign it to the Wasatch genus *Ototriton*. This tentative assignment is an expedient adopted as the lesser of two evils, since it seems far preferable to include it in an established genus rather than to create a new genus on a mediocre specimen.

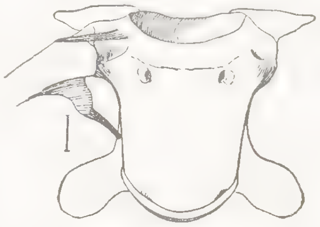

Fig. 22.—Middorsal vertebra of *Amphisbaena alba* Gray. (No. 8747, Amer. Mus. Nat. Hist.) About four times natural size. (After Camp)

The large size of the type vertebra will serve to distinguish this species from the Oligocene amphisbaenians. The specimen is of further interest as being the first amphisbaenoid reptile to be recognized in the Bridger fauna.

REFERRED SPECIMENS

No. 1096, Yale Museum. A single dorsal vertebra. Bridger, Eocene, Bridger Basin, Uinta County, Wyo. Collected by G. M. Keasbey, September 19, 1871.

Genus HYPORHINA Baur

Hyporhina Baur, G., Amer. Nat., vol. 27, 1893, p. 98.

Genotype.—Hyporhina antiqua Baur.

Characters.—Nostril opening on the lower surface of the snout. A postorbital arch. Prefrontal small, excluded from the boundary of the orbit by the maxillary and frontal; squamosal distinct; premaxillary, nasals, and frontals nearly meeting in one point; four teeth on each maxillary. Contains the single species *H. antiqua*.

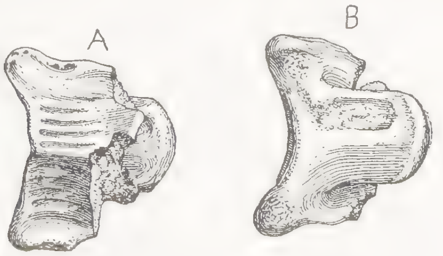

Fig. 23.—Dorsal vertebra of *Ototriton anceps* (Marsh). Type. (No. 520, Yale Museum.) About three times natural size. A, viewed from above; B, viewed from below

At the time of describing *Hyporhina antiqua*, Baur proposed the new family Hyporhinidae for its reception. It was characterized by the "presence of a postorbital arch and the very peculiar prefrontal." While these features may be of sufficient morphological importance to justify the establishment of a distinct family, I now think the systematic position of the species is adequately expressed by its inclusion in the family Amphisbaenidae, since its other structural details, so far as known, are essentially typical of that family.

HYPORHINA ANTIQUA Baur

(Pl. 1, figs. 1, 1a, 1b)

Hyporhina antiqua Baur, G., Amer. Nat., vol. 27, 1893, p. 998.—Cope, E. D., Rep. U. S. Nat. Mus., for 1898, (1900,) p. 684 (as *Hypsorhina*).—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 477 (as *Hypsorhina*).—Eigenmann, C. H., Proc. Washington Acad. Sci., vol. 4, 1901, p. 534 (as *Hypsorhina antigua*).—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 40.—Eigenmann, C. H., Pub. 104, Carnegie Inst. Wash., 1909, p. 48 (as *H. antigua*).—O'Harra, C. C., Bull. No. 13, South Dakota School of Mines, 1920, p. 60 (as *H. antigua*).

Type specimen.—Princeton University, catalogue No. 11390. Consists of a complete articulated skull and lower jaws. Collected by J. B. Hatcher, 1893.

Type locality.—Battle Draw Spring, Washington County, S. Dak.

Horizon.—Probably Leptauchenia beds,[53] "Uppermost White River" formation, Oligocene.

> *Original description.*—The smaller skull measures only 10 by 5½ mm. It is at once distinguished from all living amphisbaenians by the presence of a postorbital arch, and the very peculiar prefrontal.
>
> The nostrils are inferior in position. The single premaxillary nearly touches the paired frontals behind. Premaxillary, nasals, frontals nearly meeting in one point. The nasals are distinct and extend to the border of the muzzel, overroofing the nostrils. Prefrontal very small, placed between maxillary and frontal; separated from the orbit by a descending process of the frontal, which forms the anterior border of the orbit. Jugal complete forming a distinct postorbital bar; it is in connection with maxillary, frontal, and parietal. Squamosal well developed and free. One small tooth on premaxillary and four on each maxillary.
>
> This form represents a new genus and a new family of the amphisbaenians, which may be called *Hyporhina* and Hyporhinidae. The species may be named *Hyporhina antiqua*.

The type and only known specimen of this species is a beautifully preserved skull with nearly complete articulated mandible. The jaws obscure certain parts of the palatal view, but the union is so close that it was deemed inadvisable to attempt their separation for fear of injuring the specimen. It is here illustrated for the first time. (See pl. 1, figs. 1, 1a, 1b.)

THE SKULL

The skull, from the center of the occipital condyle to the tip of the muzzle, measures 10 millimeters in length; its greatest width is 5 millimeters. Like all the Amphisbaenidae the skull is thick and strongly ossified.

The elements forming the occipital part of the skull are all coossified, so that it is quite impossible to determine the exact limits of its component parts. The basioccipital, basisphenoid, and presphenoid are coalesced into a single bone which constitutes the chief keel of the superstructure. The posterior ventral surface of the basioccipital is oblique to the longer axis of the skull, looking backward and downward; the single occipital condyle is wider than high and broadly concave transversely. The foramen magnum is relatively large, being higher than wide. The supraoccipital above this foramen is broad as compared with the homologous part in *Rhineüra hatcherii*, and its superior junction with the overlying parietal is marked by a small, subcircular foramen. Laterally the occipital bones join by suture with the parietal as far back as the top of the foramen magnum. (See pl. 1, fig. 1a.) This portion of the supraoccipital is strongly inclined forward.

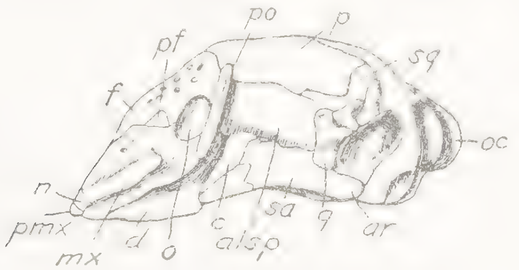

FIG. 24.—Skull and lower jaws of *Hyporhina antiqua* Baur. Type. (No. 11390, Princeton Univ.) Four times natural size. Outer view of left side. *alsp*, alisphenoid; *ar*, articular; *c*, coronoid; *d*, dentary; *f*, frontal; *mx*, maxillary; *n*, nasal; *o*, orbit; *oc*, occipital condyle; *p*, parietal; *pf*, prefrontal; *pmx*, premaxillary; *po*, postorbital bar; *q*, quadrate; *sa*, surangular; *sq*, squamosal

The exoccipitals are short and heavy, their outer ends being directed forward, and closely joined to the posterior border of the squamosal, as shown in Figure 25. Posteriorly the exoccipital is pierced by a small foramen which is situated in a deep vertical depression immediately external to the foramen magnum. It probably represents the point of exit of the hypoglossal nerve (XII). The outer end or paroccipital process terminates in a thickened and expanded end. The lower side of this end contributes to the formation of the upper and posterior boundaries of the external auditory meatus. (See fig. 24.)

The parietal, compared with that of *Rhineüra hatcherii*, is short; it roofs over the whole brain case and continues downward on the side to meet the lateral bones of the brain case, probably the proötic and alisphenoid, although I am unable to differentiate those bones in the present specimen. An inverted U-shaped depression extends upward from the junction of the parietal and supraoccipital on the posterior slope of the parietal, forward of which the parietal presents a very short, transversely rounded sagittal crest. From this point forward the parietal rapidly widens, sending out short, divergent, pointed processes that are wedged in between the frontal and postorbital as shown in Figure 24. The median anterior termination of the parietal is a wide, bluntly pointed process that projects well forward between the frontals, as in the existing *Monopeltis sphenorhynchus*.[54] Posterior and lateral to the supraoccipital the parietal meets the forward border of the squamosal by a straight but forwardly directed suture. (See fig. 24.)

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[53] See footnote as to age, page 35.

The paired frontals are very large bones, being longer than broad and meeting nearly in a point with the premaxillary and nasals; laterally they roof over the borders of the orbits. A descending, pointed process contributing to the posterior boundary, and a similar anterior process descend to meet the maxillary, which entirely excludes the prefrontal from participation in the boundary of the orbit. Posteriorly the frontals are in contact with the parietal and postorbital. (See fig. 25.) The latero-posterior superior surfaces of the frontals are roughened by pits and a few short, shallow grooves.

The paired nasals are of irregular shape, meeting narrowly at a point on the median line, extending to and forming a narrow portion of the muzzle between the maxillary and premaxillary bones and roofing over the external nares which open on the lower side as in *Rhineüra hatcherii*. Viewed from above the premaxillary is triangular in outline. On the palatal surface it supports a single median tooth. The premaxillary forms the inner borders of the nares, not being excluded from it by a process of the maxillary as in *Rhineüra hatcherii;* also, the width between the nares is relatively greater than in that form. The posterior extension of the palatal portion of the premaxillary is covered by the rami so that its relationship to the vomers can not be determined.

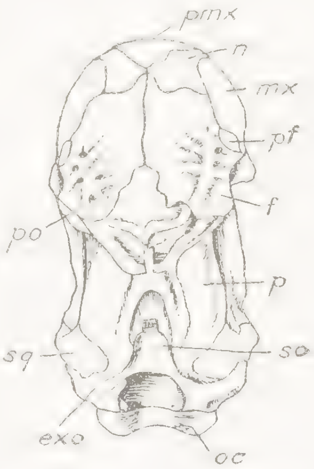

FIG. 25.—Skull of *Hyporhina antiqua* Baur. Type. (No. 11390, Princeton Univ.) Four times natural size. Viewed from above. *exo*, exoccipital; *f*, frontal; *mx*, maxillary; *n*, nasal; *oc*, occipital condyle; *p*, parietal; *pf*, prefrontal; *pmx*, premaxillary; *po*, postorbital bar; *so*, supraoccipital; *sq*, squamosal

The prefrontal is a very small triangular bone that is wedged in between the frontal and maxillary and is entirely excluded from the border of the orbit by a descending process of the frontal.

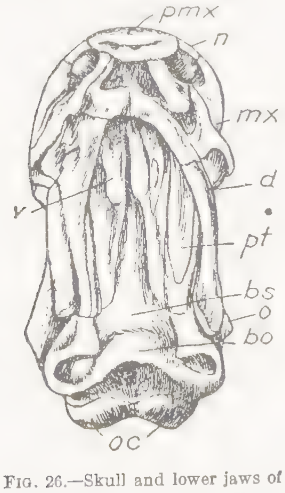

FIG. 26.—Skull and lower jaws of *Hyporhina antiqua* Baur. Type. (No. 11390, Princeton Univ.) Four times natural size. Viewed from below. *bo*, basioccipital; *bs*, basisphenoid; *d*, dentary; *mx*, maxillary; *n*, nasal; *o*, orbit; *oc*, occipital condyle; *pmx*, premaxillary; *pt*, pterygoid; *v*, vomer

The maxillary is relatively short and carries four small, pointed teeth. The teeth are set well back under the bone so that as the external surface turns back toward them it forms a thickened, overhanging shelf which is perforated on the lower side by three or more small dental foramina. The teeth appear to be acrodont in attachment.

The postorbital is complete on the left side (see pl. 1, fig. 1), being a slender bar of bone that unites with the posterior extremity of the maxillary below and extends upward forming a distinct postorbital bar and uniting with the frontal and parietal above.

Williston [55] recognized a postorbital element in the skull of *Amphisbaena alba* (see fig. 27), the only recognition of this bone in the living Amphisbaenidae, so far as I am aware.

The squamosal is distinct, higher than wide, and is wedged in between the parietal and exoccipital on the side of the brain case; its lower end is produced outward into a strong process that caps over and furnishes articulation for the quadrate.

The quadrate is short and stands even more perpendicular than in *Rhineüra*. Its upper extremity presents two distinct parts: An articular face is received in under an overhanging process of the squamosal and forms the principal articulation of these elements; an anterior part in the form of a blunt process arises above and in advance of the quadrato-squamosal articulation.

The parietal-alisphenoid suture is much higher on the side of the brain case than in *Rhineüra hatcherii*, but I am unable to delimit the alisphenoid.

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[54] Peters, W., Reise Nach Mosambique, 1842–43, vol. 3, pl. XIIIa, fig. 3a.

[55] Contrib. Walker Museum, Univ. Chicago, vol. 2, 1918, p. 82.

The palatal aspect is obscured by the closely attached mandibles, but the large pterygoids appear to be much like those of *Rhineüra hatcherii* lying closely appressed to the sphenoidal bones with their posterior ends abutting against descending buttresses of the basisphenoids.

LOWER JAW

The lower jaw is badly crushed, though dentary, coronoid, angular, splenial, and surangular and articular bones can be recognized. The dentaries are broadly curved at their anterior extremities in order to better conform to the broad muzzle of the skull. The number of teeth carried by the dentary can not be determined from this specimen. Posteriorly the relative length of the dentary is like that in *Rhineüra*, reaching nearly to the posterior limits of the coronoid. There is no trace of the Meckelian groove.

The left coronoid, which has lost its upper extremity, appears very similar in shape and extent to the coronoid of *Rhineüra hatcherii.* Unlike the latter, the precoronoidal part of the jaw considerably exceeds the postcoronoidal part, in this feature more nearly approaching the condition found in the existing *R. floridana.* The posterior extension of the articular is relatively shorter than in the contemporary *R. hatcherii.*

The limits of the angular and splenial are too obscure to allow a detailed description. The surangular and articular are so firmly coossified as to appear as a single bone. The greatest length of the left dentary is 5.7 mm.

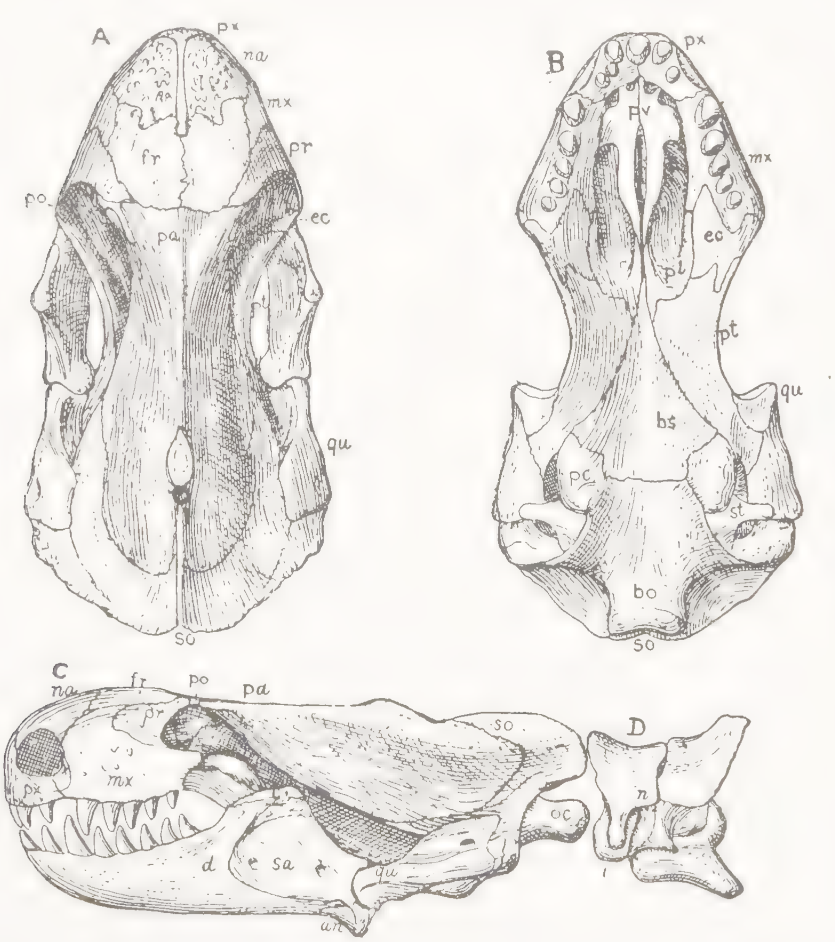

FIG. 27.—Skull of *Amphisbaena alba* Gray. A, upper view; B, lower view; C, outer view; D, atlas and axis enlarged. *an*, angular; *bo*, basioccipital; *bs*, basisphenoid; *c*, coronoid; *d*, dentary, *ec*, ectopterygoid; *fr*, frontal; *i*, intercentrum of atlas; *mx*, maxillary; *n*, neural process of atlas; *na*, nasal, *oc*, occipital condyle; *pa*, parietal; *pc*, paroccipital; *po*, postorbital; *pl*, palatine; *pr*, prefrontal; *pt*, pterygoid; *pv*, vomers; *px*, premaxillary; *qu*, quadrate; *sa*, surangular; *so*, supraoccipital. (After Williston)

Monopeltis sphenorhynchus as figured by Peters shows striking resemblances to *Hyporhina* in the short head with broadly rounded muzzle, and with large frontals. The skulls of both of these forms are in striking contrast to the elongated *Rhineüra* skull.

Section ANGUIMORPHA

Anguimorpha, Fürbringer, M., Jenaische Zeitschrift, vol. 34, 1900, p. 621.

Clavicles simple; osteoderms, when present, simple, and often corresponding in extent with the horny scales; tooth replacement usually alternate; teeth frequently conical, pointed, and recurved; caudal chevrons often attached centrally.

Subsection Platynota

Seven or more cervical vertebrae; dorsal vertebrae of highly modified procoelous type; centra short, cylindrical, or tapering; condyles very large and with flanges well developed; caudal chev-

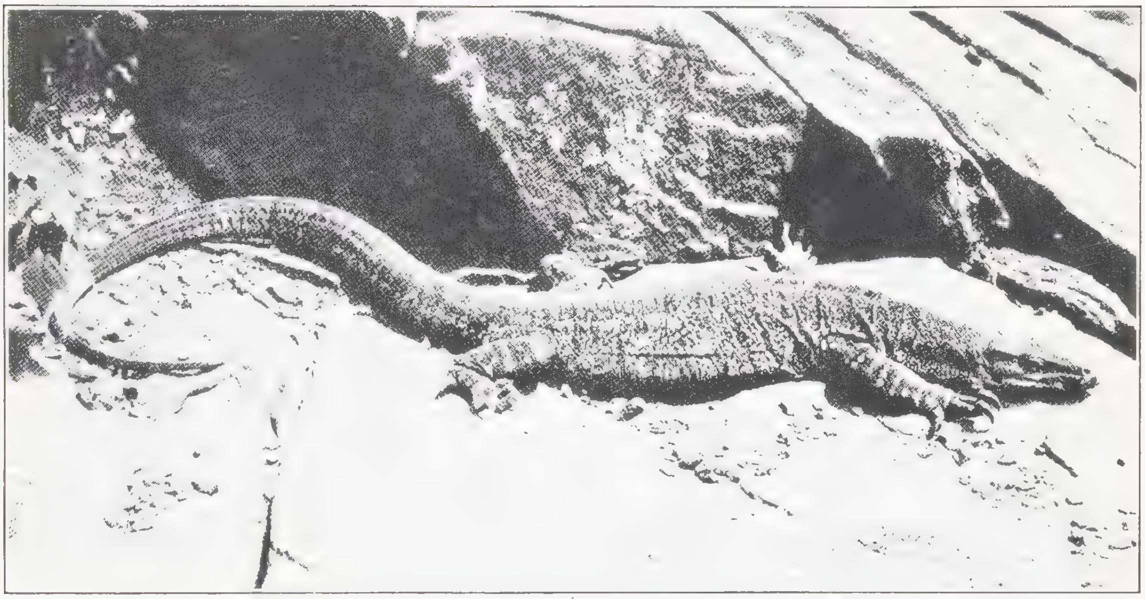

Fig. 28.—Varanus, existing Australian monitor lizard. (After Williston)

rons pediculate and articulated (rarely fused) near the middle of each centrum; no transverse suture in the caudal centra; nasals elongate, fused; premaxillaries elongate; lower jaw with median transverse sutural joint (Mosasauroidea); a parietal foramen; no osteoderms nor bony skull plates; dorsal scales granular (rhomboid on some parts in *Varanus* and in the aigialosaurs, dolichosaurs, and mosasaurs, according to Nopcsa.[56])

Key to superfamilies of Platynota

Centra depressed, articular surface of condylar ball directed dorsally; digits with claws and without hyperphalangy; a sacrum .... Varanoidea.
Centra cylindrical; condyles directed posteriorly; limbs paddle-shaped; digits without claws and with hyperphalangy; no sacrum .... Mosasauroidea.

Superfamily VARANOIDEA Camp

Postorbital bar usually incomplete; seven or more cervical vertebrae; centra depressed, condylar surfaces but little apparent in ventral view; clavicles present (perhaps lacking in Dolichosauridae); limbs ambulatory, with claws and without hyperphalangy; sclerotic ring cartilaginous.

Three families enter into this superfamily, which, following Camp,[57] may be characterized as follows:

Propodials normal; 7 cervical vertebrae .... Varanidae.
Upper Cretaceous to Recent.
Propodials shortened; 7 cervical vertebrae .... Aigialosauridae.
Lower Cretaceous.
Propodials shortened; 13 cervical vertebrae .... Dolichosauridae.
Cretaceous.

The Varanidae contains extinct forms of both the Old and the New World, as well as living representatives of the former; the other two families contain extinct European forms only and hence will not be discussed in this paper.

Family VARANIDAE

Temporal arcade complete; supratemporal fossa not roofed over by dermal bones; single premaxillary bone; parietal single; frontals entirely surrounding the olfactory lobes of the brain; columella cranii present; nasals coalesced and narrow; infraorbital vacuity bounded by the pterygoid, palatine, and ectopterygoid, the maxillary being excluded; pterygoids and palatines widely separated; palate with or without teeth; splenial bone well developed, Meckel's groove exposed; coronoid produced anteriorly and not posteriorly on external face of ramus; angular little developed on inner, much developed on outer side of ramus; surangular distinct; dentary not produced posteriorly, teeth large size and dilated at the base; subpleurodont. Hameal surfaces of the dorsal vertebrae broad, flat, occasionally rounded, and devoid of carina; vertebrae with or without vestigial zygosphene and zygantrum. No dermal ossifications; clavicle slender; interclavicle anchor-shaped; coracoids usually with two emarginations, sometimes one as in *Saniwa*.

In the above characterization I have selected from the definitions of Lydekker,[58] Boulenger,[59] Fejérváry,[60] and Cope [61] such parts as apply to the bony structure and hence are applicable to the fossil forms. Additions and modifications of my own are added to harmonize the definition for the inclusion of the fossil members now referred to this family.

Camp [62] has recently proposed the division of the Varanidae into three new subfamilies: the Varaninae to include the fossil and recent species placed in the genus by Fejérváry;[63] The

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[56] Beitr. Pal. und Geol. Oster.-Ung., vol. 15, 1903, pp. 31–42.
[57] Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p. 300.
[58] Cat. Foss. Reptilia and Amphibia in British Mus., Pt. 1, 1888, p. 281; Cat. Foss. Lizards in British Mus., vol. 11, 1885, p. 303.
[59] Fauna British India, Rept. A, Batrachians, 1890, pp. 160–161.
[60] Annals Mus. Nat. Hungarici, vol. 16, 1918, p. 365.
[61] Ann. Rep. Smithsonian Inst., 1898, p. 470.
[62] Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p. 320.
[63] Ann. Mus. Nat. Hungarici, vol. 16, 1918, p. 448.

Saniwinae for the North American Eocene genera *Saniwa* Leidy and *Thinosaurus* Marsh; and Megalaninae, substituted for Megalanidae of Fejérváry.[64] These subfamilies were founded largely on vertebral characters, on which basis alone I am fully convinced they can not be satisfactorily maintained. It seems advisable, therefore, to adopt Camp's classification only in part.

Some paleontologists, no doubt, will contend that Saniwinae should now be given family rank. The presence of teeth on pterygoid and palatine bones; reduced premaxillary without inferior spine; numerous teeth in the jaws; the presence of vestigial zygosphenes; coracoid with a single anterior notch; hypapophyses on first five cervical vertebrae, vestigal on the sixth; low, broad (anteroposteriorly) neural spines on the caudal vertebrae, are surely an array of characters not to be lightly regarded. However, in the present lack of knowledge concerning the skeletal structure of the extinct European varanids, their true relationship to the American *Saniwa* can not be closely ascertained, but that all belong to a stock that has not been widely distinct seems fully expressed in Camp's classification, which is here adopted, with the exception that the subfamily Saniwinae shall now include his Megalaninae.

Key to the subfamilies of the Varanidae

Teeth not present on palatal bones; no zygosphene or zygantrum on dorsal vertebrae	Varaninae.
Teeth present on pterygoid and palatine bones; vestigial zygosphene always and zygantrum sometimes present on dorsal vertebrae	Saniwinae.

Subfamily VARANINAE Camp

The Varaninae includes the living genus *Varanus* and possibly all of the Old World Tertiary forms excepting *Megalania*. At this time no members of this subfamily are known to occur in North America.

The extinct Old World members have been thoroughly reviewed and discussed in Fejérváry's excellent paper, "Contributions to a monograph on fossil Varanidae and Megalanidae," and, as he has so clearly pointed out, are very unsatisfactorily known. Of the 10 extinct species described he regarded only four of "established specific value." Most of the extinct members seem extremely like the living genus and form a long line of descent since the Lower Eocene, occurring successively in Eocene, Oligocene, Miocene, Pliocene, and Pleistocene formations, and are, without exception, referred by Fejérváry to the living genus *Varanus*. The living members of the Varaninae form a group of more than 30 species which inhabit the tropical parts of Africa, southern Asia, Malasia, and Australia. (See fig. 29.) All are carnivorous in habit, feeding upon small backboned animals, insects, and especially upon eggs, which they crush between their teeth while holding them aloft. Most of the species live wholly upon the land. *Varanus prasinus* is supposed to be arboreal; others, as *V. salvator* and *V. niloticus*, owing to the fact that their tails are strongly compressed, are excellent swimmers and deserve the name of water lizards. The strictly terrestrial species, as *V. griseus*, have rounded tails.

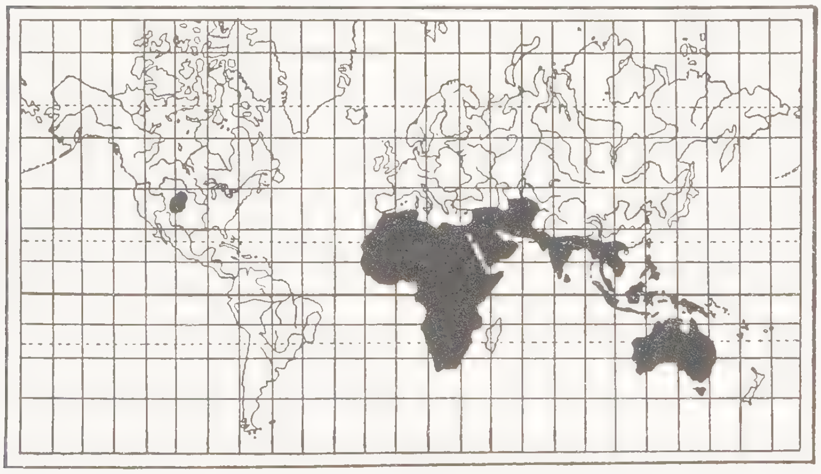

FIG. 29.—Map showing the past and present distribution of the Varanidae. Modified from Schmidt

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[64] Op cit.

Subfamily SANIWINAE Camp

Teeth numerous, subpleurodont; teeth on pterygoid and palatine bones; reduced premaxillary without inferior spine; coracoid with single emargination; vestigial zygosphenes present on dorsal vertebrae.

The Saniwinae now includes the extinct American genera *Saniwa*, *Palæosaniwa*, *Parasaniwa*, and, tentatively, the Australian genus *Megalania*. The last was regarded by Fejérváry[65] as pertaining to a distinct family, the Megalanidae, established largely on the presence of a vestigial zygosphene and zygantrum, and the very small size of the neural canal in the vertebrae. It does not appear to me that the characters deduced in support of the establishment of this family are sufficient; neither do I regard them of sufficient weight to characterize the subfamily Megalaninae proposed by Camp.[66] Until more is known of the structural characteristics of *Megalania prisca*, the presence of zygosphenal articulations of the vertebrae appears to show its affinities as being with the subfamily Saniwinae, to which it is here provisionally referred.

The new genera *Palæosaniwa* and *Parasaniwa* are imperfectly known forms based on fragmentary specimens found in the Belly River and Lance formations of Canada and Wyoming respectively. They are tentatively included in the subfamily Saniwinae.

Key to the genera of the subfamily Saniwinae

Medium sized; teeth subpleurodont with trenchant borders, recurved, spaced as in *Varanus;* vertebrae elongate, with usual sized neural canal, and flattened or rounded ventral surfaces without longitudinal channel	*Saniwa.*
Medium sized; dorsal vertebrae with decided longitudinal depression on ventral surfaces	*Palæosaniwa.*
Typically very small; teeth subpleurodont with trenchant borders, straight or slightly recurved; closely placed in jaws; vertebrae unknown	*Parasaniwa.*
Very large; teeth subpleurodont with serrated borders, recurved; vertebrae short with small neural canal, rounded ventral surfaces without longitudinal channel	*Megalania.*

Genus SANIWA Leidy

Saniwa Leidy, J., Proc. Acad. Nat. Sci. Philadelphia, 1870, p. 124.
Thinosaurus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 299.

Genotype.—*Saniwa ensidens* Leidy.

Characters.—Dentition subpleurodont, teeth recurved, with trenchant borders, widely dilated bases, and spaced as in *Varanus;* teeth in single row on pterygoids and palatines; postorbital-postfrontals distinct; premaxillary reduced in size; hypapophyses on first five cervical vertebrae, vestigial on the sixth; coracoid with single anterior emargination; skull relatively large in relation to length of presacral vertebrae.

The genus *Saniwa* was established by Leidy on a specimen from the Bridger formation, Middle Eocene, of Wyoming. The type species is apparently identical with *Thinosaurus leptodus* Marsh, which becomes a synonym. A comparison of *S. ensidens* with the other described species of *Thinosaurus* shows them to be congeneric, and the genus therefore becomes a synonym of *Saniwa* which has priority.

In establishing the genus *Thinosaurus*, Marsh makes the following observations:

> This genus includes a number of large carnivorous lizards, which resemble, in some respects, the Varanidae, or Monitors. The vertebrae are similar in form to those of *Varanus*, but differ in being joined together, especially in the dorsal region, by a peculiar modification of the zygosphenal articulation. This is essentially a repetition of the anterior zygapophyses by an intermediate and diminutive pair of wedge-shaped processes, which replace the usual zygosphene seen in the vertebrae of Iguanas and Serpents. In the caudal vertebrae, this articulation gradually subsides to a low roof, projecting in front over the neural canal. The zygantral cavities are distinct, but not so deep as in the Iguana. They are separated in the anterior vertebrae by a median ridge, the sides of which fit against the articular faces of the small intermediate zygapophyses. Some of the cervical vertebrae had free articulated hypapophyses, as in the Mosasaurid reptiles. The bones of the skull are smooth and were evidently without osseous dermal scutes, which was doubtless the case also with the rest of the body. There was a parietal foramen. The teeth are pleurodont, and, in the specimens at present

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[65] Op. cit.

[66] Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p. 321.

known, have broad expanded bases. All the species appear to have had a long tail, and were probably good, swimmers. This genus may be readily distinguished from *Glyptosaurus* Marsh, by the absence of the ornamented dermal plates, which protected all of the species of that group. The genus *Saniwa* of Leidy is probably more nearly related, but so far as now known the vertebrae appear to have been united only by the usual articulation.

As here employed, the genus *Saniwa* will include five American species, the type, *S. ensidens*, *S. paucidens* (Marsh), *S. crassa* (Marsh), *S. agilis* (Marsh), and *S. grandis* (Marsh). It seems more than possible that some of these may prove, upon the discovery of better preserved specimens, to be invalid.

The genus has a known geological range from the Upper Paleocene to the Oligocene. Dollo has recently recognized it in the Upper Sparnacian (Upper Paleocene) of Belgium, describing the new species *S. ormaelensis* as the oldest known varanid, a statement which, in the light of more recent discoveries, now needs modification.

Key to species

Typically of medium size; ventral surfaces of dorsal vertebrae slightly convex transversely	*S. ensidens.*
Typically of large size; ventral surfaces of dorsal vertebrae convex transversely, concave longitudinally	*S. paucidens.*
Typically of largest size; ventral surfaces of dorsal vertebrae convex; zygantra infolded forming shelves beneath cavities thus inclosed	*S. grandis.*
Typically of large size; ventral surfaces of dorsal vertebrae flattened or slightly concave transversely, straight longitudinally	*S. crassa.*
Typically of smallest size; ventral surfaces of dorsal vertebrae as in *S. ensidens.* Outline of arch between posterior zygapophyses decidedly concave; nearly straight in other species	*S. agilis.*

Geologic distribution of the species of Saniwa

Period		Formation		Species
Oligocene		Oreodon zone		*Saniwa* sp.
Eocene	Upper	Uinta	C	*S. paucidens.*
			B	*S. crassa.*
			A	
	Middle	Bridger	C	*S. agilis, S. crassa, S. paucidens.*
			B	*S. ensidens, S. grandis, S. paucidens.*
			A	
		Huerfano	Upper	*Saniwa* sp.
			Lower	*Saniwa* sp.
		Wind River		*S. grandis.*
	Lower	Wasatch		*Saniwa* cf. *ensidens*, *Saniwa* sp.

SYSTEMATIC AND PHYLETIC RELATIONSHIPS

Until the publication of a new description of the type of *Saniwa ensidens* in 1922,[67] little was known of the true affinities or relationships of this genus. Leidy, in 1873,[68] on very scanty information, briefly diagnosed its relationships as follows:

> The remains belong to a lacertian about the size of the existing monitor of the Nile, to which it appears to be closely related. The bones indicate a robust body, a long tail, and limbs with long toes.
>
> The vertebrae resemble those of the Nilotic monitor in form and proportions, and like them possess no zygosphenial articulation.

Though mistaken in regard to the absence of the zygosphenial articulations, the correctness of his deductions appears almost uncanny in view of his limited information regarding the skeletal structure. The varanid relationship of the genus, as indicated by Leidy, was accepted by nearly all American paleontologists and systematists, but Lydekker,[69] Zittel,[70] and Broili[71] ranged this problematical genus with the Anguidae, so that, in their opinions, it would not even be related to the Platynota but to the suborder Lacertilia vera.

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[67] Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 60, pp. 1–28.

[68] Hayden's Rep. U. S. Geol. Surv. Terr., vol. 1, 1873, p. 181.

[69] Cat. Amphibia and Reptilia in Brit. Mus., Pt. 1, 1888, p. 278.

[70] Handbuch der Pal., vol. 3, 1890, p. 608.

[71] Gründzüge der Paleont. (Paläzool.), vol. 2, 1911, p. 210.

Boulenger [72] thought it very probable that *Thinosaurus*, which I regard as congeneric with *Saniwa*, belonged to the Teiidae. Nopcsa,[73] however, considered it a varanid. Fejérváry [74] also included *Saniwa* under the Varanidae but with the remark "uncertain systematical position." His more extended remarks follow:

> After a conscientious perusal of Leidy's description and drawings, I am obliged to confess to the genus *Saniwa* yet appearing a complete mystery to me. Neither the description nor the drawings throw sufficient light on even the most important characters. The humerus, for instance, presents a particularly birdlike appearance, as Leidy himself very judicially remarks.[75] The vertebrae, on the other hand, do indeed resemble those of *Varanus* although the figures allow no perceptive as to the shape of the dorsal surface. It must be taken into consideration, however, that the vertebrae of an Anguidae and Varanidae in many respects bear great likeness to each other, for which reason the resemblance with *Varanus* can not be judged as a decisive phenomenon. Moreover it does not seem impossible that the vertebrae will ultimately prove to belong to Varanidae and will thus have to be separated from at least a part of the remains left.

The above is a very logical and concise summary of the status of the genus *Saniwa*, based on the scanty information at that time (1918) available to Fejérváry. The recent preparation and description [76] of the type materials, however, showed the genus to be founded on an adequate specimen, thus removing most of the uncertainty and dissipating the existing confusion in regard to its family relationships. That its original assignment to the Varanidae by Leidy was justified has been fully confirmed. The genus was also definitely distinguished from *Varanus*, and its retention in the family Varanidae proposed, a view that is strengthened by this more recent study.

The incompleteness of the postorbital bar; pterygoids and palatines widely separated; infraorbital fossa bounded by pterygoid, palatine, and ectopterygoid, the maxillary being excluded; subpleurodont dentition; teeth pointed with dilated bases; dorsal centra with large, flattened haemal surfaces devoid of carina; large condyles with precondylar constriction; and absence of dermal scutes, constitute a combination of characters, together with the close resemblance of many of the bones of the skeleton to the living *Varanus*, which leave no uncertainty as to the true membership of *Saniwa* in the Varanidae.

In its general skeletal structure *Saniwa* is typically varanid, and there would appear but slight question that it represents the ancestral group from which the extinct and modern *Varanus* was derived. Its geological occurrence in the Upper Paleocene of Belgium and in the Lower, Middle, and Upper Eocene of America is entirely in accord with such a hypothesis.

The presence of an apparently diminishing zygosphene, teeth on pterygoid and palatine bones, single anterior notch in coracoid, intermediate number of hypapophyses on cervical vertebrae, robust on axis and reducing posteriorly, and uniformly low, broad (anteroposteriorly) spinous processes, are all features indicating affinities with the Mosasauridae, and supporting the contention of Williston [77] that "it seems best to unite the monitors, dolichosaurs, and aigialosaurs into one group of the Lacertilia, the Platynota, intermediate in place between the true land lizards and the truly aquatic mosasaurs."

The soundness of the above conclusion appears to be given additional support by this study of the genus *Saniwa*, which furnishes the details of a much earlier stage of varanid development than was previously known. It supplies an additional link in the ancestral chain which connects the strictly aquatic and semiaquatic lizards of the Lower and Upper Cretaceous with the monitors of the later Tertiary and Recent periods. If the evidence cited above has been correctly interpreted, it should go far toward a settlement of a controversy that has been waged since the time of Cuvier, who was the first to pronounce relationships between the two groups.

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[72] Proc. Zool. Soc. London, Jan. 30, 1921, p. 115.

[73] Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 49.

[74] Ann. Mus. Nat. Hungarici, vol. 16, 1918, p. 363.

[75] This bone was described by Leidy as pertaining to *Saniwa major*. It has recently been made the type of an extinct owl (see p. 80).

[76] Gilmore, op. cit.

[77] Water Reptiles of the Past and Present, 1914, p. 147.

SYNOPSIS OF THE OSTEOLOGICAL CHARACTERS OF SANIWA

Skull.—Skull long in relation to length of presacral vertebrae; premaxillary relatively small with superior spine, inferior spine absent; parietal perforated by pineal foramen on frontoparietal suture; prefrontal large; lachrymal perforated posteriorly by two enclosed foramina; postfrontal and postorbital distinct; postfrontal and jugal probably in contact to complete the arch; exoccipitals with short horizontal plate; pterygoids widely separated and bearing row of small, pointed teeth; palatines moderately separated and bearing a row of five or more palatine teeth; vomers robust, slightly separated posteriorly, lingual grooves present; maxillary excluded from border of infraorbital vacuity; maxillary attenuated posteriorly; occipital condyle distinctly tripartite.

Jaws.—Lower jaw with vertical suture near middle; dentary long, tapering; angular small, narrowly visible on external side; surangular extensive; extension back of cotylus relatively short with a heavy hooklike internal-ventral expansion of end.

Teeth.—Six premaxillary teeth; 48 maxillary teeth; 44 ? dentary teeth; posterior teeth recurved, compressed, sharply pointed, trenchant borders, dilated bases having vertically striated surfaces; anterior teeth small, cylindrical, incurved; teeth spaced as in *Varanus.*

Vertebrae.—Vertebrae moderately elongated, tapering, with articular surface of condylar ball directed dorsally; cervicals bearing hypapophyses on first five vertebrae, vestigial on the sixth; hypophyses decreasing in size from second backwards; dorsals with vestigial zygosphenes; ventral surfaces of dorsal vertebrae flattened, grooved, or slightly convex; neural spines relatively low, and broad antero-posteriorly; two sacral vertebrae, chevrons attached to facets on posterior third of centra; neural spines of caudals relatively low.

Arch and limb bones.—Pelvic arch similar to *Varanus;* coracoid with single anterior emargination; interclavicle anchor-shaped; humerus having distal end abruptly expanded.

SANIWA ENSIDENS Leidy

(Pl. 3; pl. 4, figs. 1, 2; pl. 5, 6, 7, and 8; pl. 9, figs. 10, 11, and 12)

Saniwa ensidens Leidy, J., Proc. Acad. Nat. Sci. Philadelphia, 1870, p. 124; Hayden's 2d (4th) Ann. Rep. U. S. Geol. Surv. Wyoming and contiguous Terr., 1871, p. 368; U. S. Geol. Surv. Montana and portions of adjacent Terr., 1872, p. 370.—King, C., U. S. Geol. Expl. 40th Par., 1878, vol. 1, p. 608.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 60, 1922, pp. 1–28, text figs. 1–22, pls. 1–3.—Camp, C., Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p. 321.—Dollo, Louis, Bull. Soc. Belge. de Geol. de Pal., et d'Hydrol., vol. 2, 1923, p. 77.

Saniva ensidens (Leidy) Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 1, 1871, p. 457.—Cope, E. D., 6th Ann. Rep. U. S. Geol. Surv. Terr. for 1872, 1873, p. 632.—Leidy, J., Rep. U. S. Geol. Surv. Terr., vol. 1, 1873, pp. 181, 344, pl. 15, fig. 15, pl. 27, fig. 35.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 46.—Fejérváry, Ann. Mus., Nat. Hungarici, vol. 16, 1918, p. 420.

Thinosaurus leptodus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, October, 1872, p. 300.—Cope, E. D., 6th Ann. Rep. U. S. Geol. Surv. Terr. for 1872, 1873, p. 632.—King, C., U. S. Geol. Expl. 40th Par., vol. 1, 1878, p. 405.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 476.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 47.

Saniwa leptodus (Marsh) Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 60, 1922, p. 25.

Type specimen.—United States National Museum, catalogue No. 2185. Consists of skull; lower jaw; atlas, axis, 6 cervical, 15 dorsal, and 22 caudal vertebrae; 18 thoracic and 3 cervical ribs; limb bones; and right coracoid. Collected by F. V. Hayden, 1870.

Type locality.—Vicinity of Granger, Sweetwater County, Wyo.

Horizon.—Bridger, Middle Eocene.

Original description—Saniwa ensidens.—Among the fossils obtained in Professor Hayden's expedition are the remains of a lacertian, labeled as having been discovered near "Granger." The bones consist of those of most parts of the skeleton, but are all in a fragmentary condition, and are imbedded in freshly broken pieces of an ash-colored rock. Before disturbance they appear to have been mostly entire and preserved nearly in conjunction. They are black, and their interior is occupied with crystalline calcite.

Fragments of bones exhibit well-developed limbs, with long toes, strong ribs, and a long tail, altogether indicating a form like that of ordinary living lacertians. The long bones even to those of the toes, are hollow. The vertebrae exhibit the ball and socket articulation of their bodies, but only a single pair of zygapophyses in front and behind. No zygantral and zygosphenal articulation appears to have existed.

The articular ball of the vertebral body is much wider than high, and is directed upward, with an inclination backward.

The body of several dorsals is quite straight inferiorly fore and aft, and measures half an inch in length. The ball is four lines wide, and about half as thick. The breadth at the anterior zygapophyses is eight lines and at the articulations for the ribs, just exterior to the latter, three-fourths of an inch.

Hypophyses for the articulation of chevrons are situated one-fourth the length of the body from the posterior extremity.

A tooth was found, after careful search, in proximity to what appear to be traces of the skull. It consisted of the crown, broken from its connection, the character of which therefore can not be ascertained.

The crown of the tooth is compressed conical, slightly curved inwardly and backward, sharp pointed, with abruptly impressed trenchant borders; is smooth and shining. It is hollow and has thick walls. The transverse section is rhomboidally oval, with acute poles. The length is about 1¼ lines; the breadth three-fourths of a line; thickness one-half of a line.

The remains would indicate an animal as long as the largest of our living iguanians.

For the generic name of the animal I would propose to use the euphonius one of *Saniwa*, which, according to Professor Hayden, is that used by one of the Indian tribes of the Upper Missouri for a rock lizard. The species may be named *Saniwa ensidens*.

The type of *Saniwa ensidens* was discovered by Dr. F. V. Hayden in 1870, and in the fall of that year was submitted to Dr. Joseph Leidy for study and description. The specimen was then deposited in the United States National Museum, where it remained for 50 years in the same unprepared condition as originally received. It was preserved in a number of blocks of ash-colored rock, the only evidence of the embedded specimen being the ventral portion of two vertebrae, which Leidy figured, and numerous ends of bones which protruded from the broken surface of the rock.

In 1921, Mr. N. H. Boss, preparator in the section of vertebrate paleontology, prepared the specimen for study by entirely freeing some of the bones from the matrix, although many, especially the vertebrae and ribs, were only worked out in relief. It was in this condition when I redescribed it.[78]

An examination of the other known North American varanid lizard remains showed this to be by far the most complete skeleton known, and the idea of mounting the articulated skeleton for exhibition at once presented itself. This has been skillfully done by Mr. Boss after several months of tedious and painstaking work, and the final results are most gratifying. Missing bones have either been replaced by casts from other individuals of the same proportions, or been modeled to form from a skeleton of *Varanus griseus*. (See pl. 8, figs. 1, 2.)

In freeing the bones from the investing matrix, elements whose former existence was unsuspected were brought to light, and a more detailed study of the separated bones than was possible in my first description is now permitted. The missing premaxillary and the anterior ends of the maxillaries and dentaries were revealed, a most welcome and unexpected discovery, as the broken ends of the posterior parts of these bones protruded from the rock and it was thought that their anterior portions were irretrievably lost. Additional caudal vertebrae, foot bones, and a few detached teeth were also recovered.

A careful comparison of the type of *Thinosaurus leptodus* Marsh (No. 612, Yale Museum) with the corresponding elements of *Saniwa ensidens*, showed such close resemblances in size and other characteristics as to leave no doubt of their identity. The dorsal vertebrae have the same flattened, slightly convex transverse ventral surfaces, with transverse elliptical cup and ball; the same rudimentary zygosphenal articulation, with ball-like diapophyses for the ribs; the teeth are similar, so far as they can be compared, the grooving of the oblique, expanded bases and the extension of the grooves upward on the lower half of the crown appearing identical. *Thinosaurus leptodus* is therefore regarded as a synonym. Marsh's original description is as follows:

Original description.—This species, which is somewhat smaller than the one above described [*T. paucidens*] is indicated by the more important parts of two skeletons, and some isolated remains of other individuals. The teeth preserved are of unequal size, with crowns slender, compressed and pointed; and curving backward and inward. The grooves at the base are deep, and pass upward over the lower half, at least, of the crown. There is a distinct cutting edge in front, but none behind on the lower part of the teeth observed. The vertebrae are very similar to those of *T. paucidens*. The articular cup is transversely elliptical, and is faintly depressed above for the neural canal. The two sacral vertebrae are *ankylosed*. Both are short, and have a deep groove on the lower surface of the expanded diapophyses. The pelvic arch is very similar to that in the Iguanas, but the ilium is pointed at its upper extremity. The caudal vertebrae have the chevrons situated about one-third the length of the centrum from the end of the articular ball. The tail was long and slender.

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[78] Op. cit.

Measurements	Mm.
Space occupied by three lower teeth	11. 0
Anteroposterior diameter of crown of lower tooth	2. 5
Transverse diameter	1. 5
Length of dorsal vertebra on lower surface	13. 6
Width of cup	9. 0
Expanse of anterior zygapophyses	16. 0
Length of two united sacral vertebrae	18. 6
Length of ilium	42. 7

Marsh failed to designate a type, though he mentions "the more important parts of two skeletons, and some isolated remains of other individuals." However, among the lizards of the Yale University collection, I found two boxes containing the specimens mentioned, and on the cover of one, in Marsh's handwriting is "*Thinosaurus leptodus* (type)." The specimen so designated agrees with the description, and especially with the measurements given by Marsh, and can, therefore, be safely regarded as the original type of *T. leptodus*.

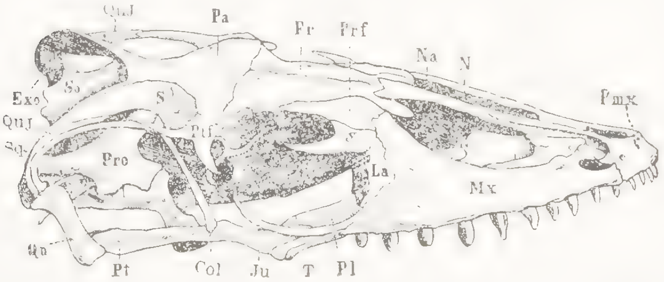

FIG. 30.—Skull of *Varanus niloticus* (Linn.). *col*, epipterygoid; *exo*, exoccipital; *fr*, frontal; *ju*, jugal; *la*, lachrymal; *mx*, maxillary; *n*, external nares; *na*, nasals; *pa*, parietal; *pl*, palatine; *pmx*, premaxillary; *prf*, prefrontal; *pro*, proötic; *pt*, pterygoid; *ptf*, postfrontal + postorbital; *qu*, quadrate; *quj*, squamosal; *s*, supratemporal fossa; *so*, supraoccipital; *sq*, tabulare; *t*, ectopterygoid; *y*, supraorbital. (After Cuvier)

This somewhat detailed explanation appears necessary in order that my reasons for using the term *type* rather than *cotypes* may be understood.

This specimen is of particular interest on account of the presence of several elements not preserved in the type of *Saniwa ensidens*. The more important of these are the coossified sacral vertebrae; coossified ilium, pubis, and ischium of the right side, and portions of the left ilium and ischium; right femur lacking the distal extremity; and a phalangial of the foot. These add considerably to the known skeletal structure of this extinct lizard.

OSTEOLOGY OF THE SKELETON

The following detailed description of the osteological structure of the genus *Saniwa* is based primarily on the type skeleton of *S. ensidens*, but in order to characterize it as fully as existing materials will permit, bones from other specimens are utilized if missing in the type.

THE SKULL

A very considerable part of the skull of the type is present. Excepting the palate shown in Plate 4, Figure 1, the other elements were found disarticulated, though not far removed from one another in the matrix. Curiously enough the larger, heavier elements, such as the parietals, frontals, and nasals, are entirely missing.

As might well be inferred from the close resemblance of its constituent elements to those of *Varanus*, the skull of *Saniwa* has the same light, open construction as in that genus. The close similarity of many of the individual bones is remarkable, especially when the Middle Eocene age of the fossil is taken into consideration.

The articulation of the separate parts of the partially dismembered skull of *S. ensidens* (see pl. 3, figs. 1, 2, and 3) gives for the first time a fairly accurate conception of the shape and proportions of the cranium as a whole. Some allowance must be made for slight distortion by crushing, and the inability on that account of accurate articulation of certain bones, which will be mentioned later. The relationship of the bones of that portion of the palate lying between the maxillae has not been disturbed, and is shown as found. There is some question as to the proper length of the missing section of the maxillaries. It appears quite probable that this has been made too long in the restored skull, but only the discovery of complete maxillaries will determine this point. It is apparent that *Saniwa* had a narrow, elongated type of skull, resembling *Varanus salvator* rather than the heavier, more abbreviated type in *V. niloticus* and *V. exanthematicus exanthematicus* (Bosc.) as figured by Schmidt.[79] In height it appears intermediate between the low, flattened head of *V. griseus* and the highly elevated cranium of *V. niloticus*. The missing bones from the superior aspect make the restoration of that part very problematical as to correctness of proportions, and need not be further mentioned. The very much larger size of the head in *S. ensidens* as compared with the axial skeleton is an important structural difference between the fossil and living species of the Varanidae. While the head has the approximate proportions of the skull of *V. salvator*, the presacral region is nearly a fifth shorter.

Measurements of restored skull

	Mm.
Greatest length at center	106.3
Greatest width across center of maxillaries	23.0
Greatest width across quadrate	55.5
Greatest width across ends of exoccipitals	37.4

Basioccipital.—The basioccipital is perfectly preserved, except for the loss of its posterior median portion, which, with the exoccipitals, forms the occipital condyle. It thus forms the median boundary of the base of the foramen magnum, and ventrally is continuous laterally with the exoccipitals, which, as in *Varanus*, develop thin, winglike plates that extend forward in a horizontal plane from the ventral sides of their proximal ends. The anterior, transversely broad, wedge-shaped end is received in a corresponding transverse depression on the posterior end of the basisphenoid. The dorsal surface of the basioccipital is medially depressed, forming a wide, longitudinal valley. (See pl. 3, fig. 3.)

Basisphenoid.—The basisphenoid of *Saniwa*, as in living lizards generally, sends downward two short processes or hypapophyses with flattened expanded ends that abut against the pterygoids, as in *Varanus*. (Fig. 32.) Between these processes at the middle it is drawn out in front into a short, truncated rostrum which articulated with the presphenoid. The posterior margin is broadly notched for the articulation of the basioccipital. The dorsal surface slopes upward from the back toward the front, this inclination being continued on either side as divergent projecting processes which in the articulated skull are lapped by a slender projecting process of the proötics. Between, and ventral to these two processes, the widened anterior end of the bone is deeply and broadly scooped out, forming the *sella turcica*, into which a pair of entocarotid canals open. On the lateral posterior surface is a foramen that in *Varanus* leads diagonally through the wall of bone into the median excavation described above. This bone in size and shape is remarkably similar to the basisphenoid of *Varanus salvator* (No. 29408, U. S. N. M., see fig. 34).

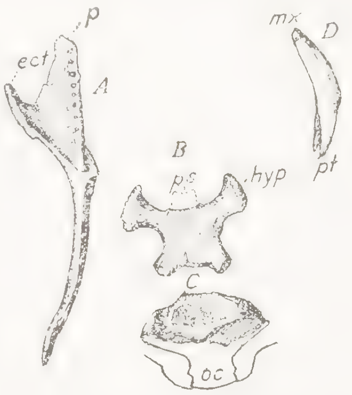

FIG. 31. Skull bones of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. Viewed from below. A, right pterygoid; *ect*, process articulating with ectopterygoid; *p*, process that articulates with the palatine. B, basisphenoid; *hyp*, hypophyses; *ps*, presphenoid, which is missing. C, basioccipital; *oc*, occipital condyle restored. D, right ectopterygoid, viewed from above; *mx*, anterior end that meets the maxillary; *pt*, posterior bifurcated end that meets the outer branch of the pterygoid

Exoccipital and opisthotic.—Both exoccipital bones are present, the left having the proötic of that side attached to it. The exoccipital contributes to the basal as well as forming all of the side boundary of the foramen magnum. The basal portion extends backward and forms the lateral portion of the occipital condyle. Articulated it would extend outward and backward as a flattened paroccipital process having a vertically expanded, truncated end, which probably articulated with the tabulare and quadrate as in *Varanus*. A foramen leads diagonally through this bone into the brain cavity, having its external exit ventral to the lower border of the paroccipital process. Beneath and forward of this vagal foramen a small, thin, winglike horizontal plate is developed which joins the lateral border of the basioccipital. In the comparatively limited development of this platelike process, with a decided notch between it and its junction with the paroccipital process, it resembles the *Iguana* much more closely than *Varanus*, where this process extends outward on the lower side of the paroccipital process for fully one-half its total length, while in *Saniwa* its extent would be less than one-fourth the total length. On the anterior side of the paroccipital process a sharp medium longitudinal ridge divides the lower nonarticular from the upper articular surface with which it unites with the posterior branch of the proötic by squamous suture. On the inner anterior end a deep pit, a part of the auditory capsule, extends down into this bone. Immediately within the foramen magnum the exoccipital is perforated by a small foramen for the passage of the hypoglossal nerve, which makes its exit beneath the base of the lateral paroccipital process. In front of this foramen is a slitlike aperture, the internal auditory meatus, through which the auditory nerve leaves the cranial cavity and enters the external ear. In the crocodile the thin bone above and in front of this slitlike opening is the opisthotic, and from the close resemblance of this portion of the *Saniwa* brain case to that of the crocodile I am led to believe that the thin bone above the slit, forming a wall between the auditory capsule and the brain cavity, is the opisthotic, which, as in many other reptiles, has become united with the exoccipital early in life. Attached to the right exoccipital is a fragment of the rodlike columella auditoris.

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[79] Bull. Amer. Mus Nat Hist., vol. 39, 1919, p. 481, fig. 8; p. 490, fig. 10.

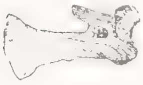
Fig. 32.—Right exoccipital of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. Posterior view

Supraoccipital.—A little more than the right half of the supraoccipital is well preserved. (See pl. 3, fig. 2.) It was found detached in the matrix, but in articulating the skull a perfect contact with the right exoccipital was found. In general shape the supraoccipital is subtriangular, whereas in *Varanus salvator* and *V. griseus* it is subquadrangular. In this respect it most nearly resembles the supraoccipital of *V. niloticus*, and especially the extinct *Megalania prisca*. Further resemblances to the latter are found in the strong keel or "processus ascendens," as called by Fejérváry, with deep excavations on both sides. The resemblance in the shape of this bone to the homologous element in the *V. niloticus* skull suggests that the skull of *Saniwa*, in the occipital region, was of the high type rather than the low, flat-headed varanids as exemplified in *V. salvator* and *V. griseus*. The upper end is truncated; the lower or posterior end forms the superior boundary of the foramen magnum, between the exoccipitals; laterally it joins the proötic and probably the opisthotic.

Epipterygoid.—The complete left epipterygoid is present, as shown in Figure 33. It is a rounded bar with slight, but about equally expanded ends. The lower end is cut off obliquely, the upper is flattened on the inner side, where it laps against the forward extremity on the proötic. This bone has a total length of 16 millimeters.

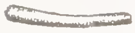
Fig. 33.—Left epipterygoid of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. Posterior view

Pterygoid.—The right pterygoid is present in its entirety; the left not quite so perfect. The latter was found in the matrix but little separated from its proper articulation with the ectopterygoid (see pl. 4) and palatine bones. The pterygoid in *Saniwa* is a long, slender, slightly curved bone, having a bifurcated anterior end and a flattened tapering posterior extremity which laps the inner distal side of the quadrate. (See A, fig. 31.) The slender, rodlike posterior portion is grooved on the dorsal and internal sides by longitudinal sulci. On the dorsal surface forward of the center of the bone the development of a shallow pit marks the point of articulation with the epipterygoid. Anterior to this cuplike depression the bone rapidly widens, being terminated at the anterior extremity by two projecting articular processes, the larger inner process uniting with the palatine, the smaller outer process with the ectopterygoid. The thin, notchlike border connecting these two processes forms much of the inner and all of the posterior boundaries of the infraorbital vacuity. The right pterygoid has a greatest length of 43 millimeters; greatest width of anterior end, 10 millimeters.

The resemblance of this bone to the pterygoid of *Varanus salvator* (compare figs. 31 and 34), is very close in size, proportions, and method of articulation with surrounding elements, the only differences observed being the deeper longitudinal sulcus on the internal side of the posterior half of the fossil bone and the higher and sharper ridges on both the ventral and dorsal sides of the border leading up to the process that meets the ectopterygoid bone.

The preparation of the ventral side of the left pterygoid disclosed the presence of a row of at least five and probably more small, pointed pterygoid teeth. These are well spaced and arranged in a single row paralleling the inner anterior border. (See fig. 31A.) In my first description I stated "there is no evidence of pterygoid teeth," this being based on a study of the right pterygoid, which had the teeth all broken off. Now that it is known that teeth were present, the broken bases of a few can easily be detected.

Palatines.—Both palatine bones, but slightly displaced from their proper position in the palate, are shown on Plate 3, Figure 3, and Plate 4. With the exception of bearing a median longitudinal row of small, sharply pointed teeth on their posterior ventral surfaces, they appear very similar to *Varanus* in shape and in their relationship to the adjacent bones of the palate. The row of palatine teeth appears to be continuous with those on the pterygoid. The exact number of these teeth can not be determined from this specimen.

On the external side, near the middle of the bone, a heavy process extends diagonally outward and forward to meet the posterior end of the maxilla. As in *Varanus*, this process is perforated by a longitudinal foramen, which leads into a cavity within the maxilla. A slender, pointed projection of this process extends backward along the maxilla, which, when properly articulated, probably meets the ectopterygoid and entirely excludes the maxilla from participation in the formation of the boundary of the pterygoid or infraorbital aperture. Anteriorly the palatine sends forward a slender, tapering process that laps the posterior end of the vomer on the inner side. The forward ends of the palatines are in contact on the median line on the dorsal side, as is clearly shown in Plate 4. After the preparation of the ventral side of the palate, I am still inclined to the belief that their close proximity has been brought about by transverse crushing and that originally they were more separated, but probably never so wide apart as in the living *Varanus*. (See fig. 34.) In the articulated skull the base of the prefrontal rests upon the median dorsal surface of the palatine, but it can not be determined whether or not it was in contact with the lachrymal bone.

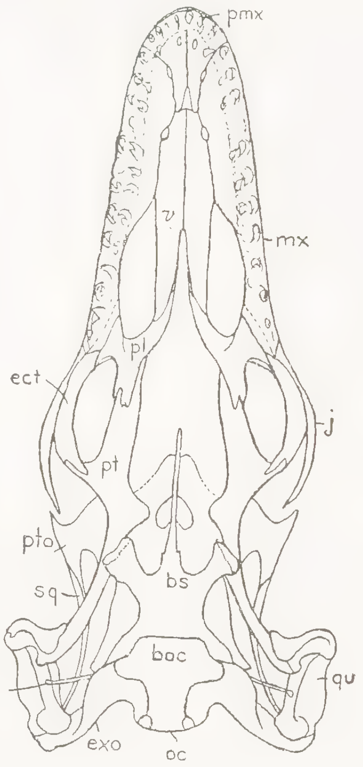

Fig. 34.—Skull of *Varanus salvator* Laur. (No. 29551, U. S. Nat. Mus.) Natural size. Viewed from below. *boc*, basioccipital; *bs*, basisphenoid; *exo*, exoccipital; *ect*, ectopterygoid; *j*, jugal; *mx*, maxillary; *oc*, occipital condyle; *pl*, palatine; *pmx*, premaxillary; *pto*, postorbital; *pt*, pterygoid; *qu*, quadrate; *sq*, squamosal; *st*, stapes; *v*, vomer

Vomers.—The ventral surface of the palatines (see pl. 3, fig. 3), shows the posterior extremities of this side to be incomplete. The vomers are relatively wider transversely and heavier throughout than in any of the *Varanus* skulls of equal size which I have examined. After a study of the palatal aspect of the vomers, I am of the opinion that only their anterior halves were in close or sutural contact on the median line. This fact is indicated by the flattened opposing surfaces of the anterior half of these bones, whereas on the posterior half the bones are beveled down to form a comparatively thin, rounded, longitudinal border that probably formed the lateral borders of a narrow V-shaped separation between them, as in the living *Varanus*. The palatal surfaces of these bones near their anterior ends are longitudinally grooved; laterally at this point their upper lateral borders turn abruptly outward to meet the maxillary and thus form the anterior border of the anterior palatine vacuity. The anterior ends of the vomers are missing in the type, as shown in Plate 4.

Ectopterygoid.—Both ectopterygoid bones are present in a nearly perfect state of preservation. This bone is curved, having a bifurcated posterior end (see fig. 31D) that straddles the small, outwardly turned process on the pterygoid, lapping above and below, thus forming a strong union of these two bones. Its curved and rounded inner border forms the greater part of the outer boundary of the infraorbital vacuity. The anterior end tapers out to an obtuse point, having a groove on the external side that joined the posterior end of the maxillary. The anterior outer border was in sutural contact with the jugal for half its entire length. Its greatest length over all is 16.5 millimeters. Anteriorly it meets the slender, posteriorly directed process of the palatine and thus excludes the maxillary from participation in the boundary of the infraorbital vacuity as in *Varanus*. (See fig. 34.)

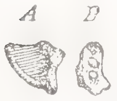

Fig. 35.—Left lachrymal of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. A, Outer view; B, posterior view

Lachrymal.—The left lachrymal is almost perfectly preserved, lacking only a little of its external posterior border. Viewed from the side, it is a flat bone, subtriangular in outline, with a thickened posterior border that is slightly concave vertically. This end, which contributed to the boundary of the orbit, is perforated by two oval foramina, one above the other. The larger is above and separated from the lower one by a very narrow filament of bone. (See fig. 35B.) These appear to have a common exit on the median internal side of the bone. In *Varanus* the lachrymal is perforated by the usual lachrymal foramen, but the larger and more dorsal foramen of *Saniwa* is, in *Varanus*, represented by a notch, the inner border being formed by the lower branch of the prefrontal. A striated articular surface on the posteroinferior border appears to indicate the point of articulation with the forward end of the jugal as in *Varanus*. Its greatest length is 7.5 millimeters; greatest height, 6.5 millimeters.

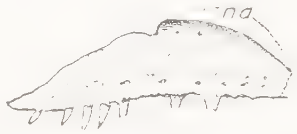

Fig. 36.—Right maxilla of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. Outer view. *na*, border contributing to the boundary of the external narial opening

Maxillary.—Both maxillae retain their natural relationships to the interposed palatal bones, as shown in Plate 4. The right is the better preserved, though it lacks a portion of the median anterior half. In so far as comparison can be made, it closely resembles the maxillary of *Varanus*. The principal differences observed are the more slender and tapering zygomatic process and the totally different contour of the upper border of the anterior extremities of the maxillae, as shown in Plate 4. Attention is called to the sudden expansion in height of the anterior portion of the maxillary and its inflection inward to a flattened turbinarial process. In this respect it approaches the conditions found in the maxillary of the extinct *Varanus dirus* De Vis, as figured by Fejérváry.[80] In this respect *Saniwa* differs so strongly from the living varanids at my disposal that I was at first inclined to regard the maxillae and the attached premaxillary bone as belonging to a different lacertilian. While there is no direct contact of these parts with the more posterior portion of the skull, their occurrence in the matrix surrounded by other parts of the skull and skeleton, with no duplication of bones to indicate the presence of other individuals, leads me to believe that they unquestionably belong to the type specimen. The small, sharply pointed pleurodont teeth retained in the jaws also aid in establishing their varanid affinities. In articulating the skull no attempt was made to modify the restored parts to conform to the peculiarities mentioned; hence, from a side view (see fig. 1, pl. 3) this part of the maxillary looks very unnatural. The exact contour of this region must await the discovery of more perfectly preserved specimens.

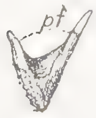

Fig. 37.—Right postfrontal of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. Viewed from above. *pf*, cupped surface which articulated about equally with the lateral projections of the parietal and frontal

The maxillae at their anterior extremities are broadly curved and in conjunction with the small premaxillary form a relatively broad muzzle. Close to the premaxillary suture the right maxillary has a vertical measurement of 2.7 millimeters; at the broken end of this anterior piece it measures 6.4 millimeters in vertical diameter. This portion of the maxillary bears 8 small, pointed teeth in a space of 7.3 millimeters. The posterior portion of the right maxillary contains 8 teeth and there are spaces for 5 more, making 13 teeth within a space of 35 millimeters. It is estimated that at least 3, possibly 4, teeth would be required to fill the restored portions of the bone, so that in all the complete maxillary of *Saniwa* would have at least 24 teeth, or 9 more than my original estimate. The lateral borders of the maxillae are pierced by a considerable number of foramina that form a row slightly above but parallel to the dental border. The sloping superior border anterior to where it joins the prefrontal forms the outer boundary of the anterior nares as in *Varanus*. The prefrontal process of both maxillae is incomplete, so that the exact manner of their union can not be determined. Posteriorly the maxillary articulates with the palatine and ectopterygoid bones of the palate, and above with the jugal, lachrymal, and prefrontal bones.

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[80] Ann. Mus. Nat. Hungarici, vol. 16, 1918, p. 414, fig. 16.

Premaxillary.—The fortunate discovery of the complete premaxillary, lacking only the posterior portion of the nasal process or spine, gives the first information as to the character of this bone in the genus. Compared with the living *Varanus* it is very much reduced in size, and contributes even less to the lateral aspect of the skull than in *V. griseus*. Its greatest transverse extent is 6.1 millimeters, whereas in a skull of *V. salvator* of equal size, this measurement is 11.7 millimeters. The basal portion of the spine is flattened, and; in relation to the alveolar portion, relatively wide. It is much depressed, but this may be due in part to distortion. At the base of and on either side of the spine the bone is concavely excavated for the articulation of the points of the maxillaries. The spine is one-half the total width of the premaxillary, whereas in *V. salvator* it is less than one-fourth. The premaxillary bears six small, closely set, cylindrical, pointed teeth of about equal size. There appears to be no median posterior palatal extension beyond that necessary to give support to the slightly enlarged bases of the pleurodont teeth. This abbreviation, taken in connection with the sudden dorsal development of the tubinator processes of the maxillae and the broadly rounded nose, suggests that perhaps the skull as now restored (pl. 3, fig. 2) is too elongated and should be more abbreviated.

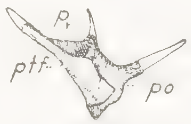

FIG. 38.—Articulated left postfrontal and postorbital of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. Viewed from above. *p*, cupped border for articulation with parietal and frontal; *po*, postorbital; *ptf*, postfrontal

Postfrontal.—The postfrontal is a moderate sized trihedral bone, articulated by its expanded cranial end to the frontal and parietal by a cupped articulation between the divergent anterior and posterior branches (see pl. 3, fig. 2) that fits in under and along the outer borders of these bones at their junction. On the posterior side of the pointed distal projection a roughened, striated surface indicates the sutural contact of the postorbital, which in *Saniwa* exists as a distinct element. The left postfrontal and postorbital were found articulated (fig. 38), the suture distinctly shown, so that the manner of their articulation may be considered as absolutely determined. In all of the illustrations of the *Varanus* skull and in three of the four skulls of this animal before me, the postfrontal-postorbital complex appears as a single bone.[81] It is called postfrontal in all the illustrations of the *Varanus* skull, there being no mention of the presence of a postorbital. However, on the ventral side of the right postfrontal of a skull of *Varanus* in the National Museum (No. 29408), the suture between it and the postorbital is visible under a glass. This suture takes essentially the same course as in the fossil specimen. Probably in a juvenile specimen the division between these two elements would be more clearly indicated; it is evident that they coalesce early in life, so that in adult specimens all trace of the suture is obliterated.

Postorbital.—Both postorbital bones are present, the left articulated with the prefrontal (see fig. 38), the right detached. The latter has an expanded anterior end which articulates with the postfrontal by a cupped articular surface developed on the upper anterior border. In position in the articulated skull it extends downward below the postfrontal as a bluntly pointed process, which at the time of writing my first description I thought did not reach the jugal, and the skull has been so articulated. However, it would not be at all surprising if this arch is complete in *Saniwa*, a condition observed by Fejérváry in some recent Varanidae. The proximity to the postorbital of the relatively robust posterior extremity of the heavy jugal would appear to indicate a junction of the two bones. Extending posteriorly, the postfrontal develops a slender tapering process which articulates with the squamosal, thus forming the supratemporal arcade as in other members of the Varanidae.

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[81] Gadow, H. Amphibia and Reptilia: The Cambridge Natural History, vol. 8, 1901, p. 542, fig. 138. Gadow recognizes these elements as the fused postorbital and postfrontal.

Proötic.—The left proötic was found attached by matrix to the left exoccipital. (See fig. 39.) It closely resembles the corresponding bone in *Varanus salvator* (see fig. 30), being a curved bone having a narrowed posterior half that laps along the upper anterior side of the paraoccipital process by squamous suture, and a flattened broader anterior half that turns upward from the horizontal at an angle of 45° to meet the parietal on the lower external side. The inner posterior border forms a junction with the supraoccipital, exoccipital, and opisthotic. The inner surface of this flattened end contributes to the formation of the lateral wall of the brain cavity and to the boundary of the auditory capsule. The ventral process, which in *Varanus* extends forward and downward to articulate with the basisphenoid, is missing in the fossil, but presumably it will be found to be much like that of *Varanus*.

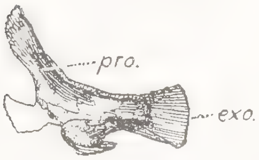

FIG. 39.—Left proötic attached to exoccipital of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.). Natural size. Outer view. *exo*, exoccipital; *pro*, proötic

Prefrontal.—The left prefrontal was found in the matrix but little disturbed from its proper articulation with the underlying bones of the palate. It is an irregularly shaped bone (see fig. 40) that forms the greater part of the anterior boundary of the orbit and contributes to both the dorsal and lateral surfaces of the skull. Internally it also develops a partial postlateral wall for the olfactory fossa. The contribution to the dorsal and lateral surfaces is of considerably greater extent, both transversely and anteroposteriorly, than in a *Varanus* skull of equal dimensions. Posteriorly a tapering process extends backward along the outer edge of the frontal, which, as in *Varanus*, probably terminated at about the center of the orbit. The anterior extension of this bone is missing. A decidedly roughened ridge is developed along the angle where it turns downward to form the lateral surface. This ridge probably marks the seat of attachment for the supraorbital bone, which is missing in this specimen. On the ventral part of the lateral surface there is an indented articular area which I first regarded as the point of articulation of the lachrymal, but which I now regard as being for a projecting point from the maxillary process. Posterior to this articulation the bone turns inward, forming a wide contribution to the anterior border of the orbit. The ventral edge of this orbital portion is slightly expanded anteroposteriorly for articulation with the underlying palatine, on which it rests in the articulated skull. Anteriorly it appears to have articulated with the maxillary much as in *Varanus*. It probably was also in contact with the nasal, but of this I am not certain.

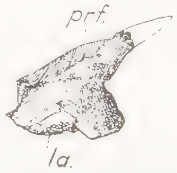

FIG. 40.—Left prefrontal of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. Outer view. *la*, surface for articulation of lachrymal; *prf*, frontal border

Parietal.—The parietal bone of *Saniwa* is now known from two specimens in the Yale Museum collection, a nearly complete parietal, No. 1074, and a fragmentary element belonging with No. 1059, a specimen which is sufficiently well preserved to be identified as *S. crassa* (Marsh). It was by comparison with this fragmentary parietal that the isolated bone above referred to was tentatively determined as belonging to the genus. As shown in Plate 9, Figure 11, this bone is complete except for the loss of portions from all four angles. Its size and general resemblance to the *Varanus* parietal leads me to this provisional assignment, but in details it differs in the more anterior position of the pineal foramen and the development of slightly raised but sharp longitudinal ridges which distinctly mark the change from the median flat surface of the bone to the descending lateral walls that form the inner boundaries of the supratemporal fossa. In the width of the broadly concave posterior border between the divergent parietal processes which are missing, this bone most closely resembles the parietal of *V. niloticus*. The pineal foramen is on the frontoparietal suture. Though a very small foramen is developed on the median line, occupying practically the same position as the pineal foramen in *Varanus*, the true pineal is much larger and lies in front in the suture as mentioned above.

Cope calls attention to the pineal foramen in lacertilians as perforating the "parietal bone clear of all sutures in most of the families, but it is near or on the frontoparietal suture in Iguanidae and Anolidae." In the Mosasauria this foramen is near or on the frontoparietal suture, and in view of the many varanoid features of their skeletal anatomy, the forward position of the pineal foramen in the Middle Eocene *Saniwa* would not be entirely unexpected. This bone has a greatest length at the center of 12.5 millimeters; greatest transverse diameter of 12.5 millimeters. The surface of the bone is smooth as in *Varanus* and the other skull bones of *Saniwa*, but the positive determination of this bone as pertaining to *Saniwa* must await the discovery of associated materials.

Quadrate.—The nearly complete left quadrate (see *qu*, pl. 3, fig. 1) shows this element in its general characteristics to closely resemble the corresponding bone of the *Varanus* skull. It is a strong bone of moderate length, having a wide articular end for articulation of the lower mandible. This end has a transverse width of 8 millimeters. Viewed from the side, the quadrate is narrow anteroposteriorly at the lower end but rapidly widens within the same diameter toward the proximal end. This widening is brought about by the inner half of the bone being inclined strongly backward from the perpendicular. The upper articular end of the inner portion rises above the upper extremity of the outer portion of the bone. In the articulated skull it is presumed that this inner surface is articulated with the tabulare and paroccipital bones as in *Varanus*. The outer half of the quadrate measures 15 millimeters in length, the inner 18 millimeters. On the inner side of the distal end a flattened facet marks the place of contact with the posterior extremity of the pterygoid.

Jugal.—The bone shown in Figure 41 was provisionally identified as the jugal in the first description, but after articulating it with the other bones of the skull, all doubt as to its identity has been removed. It is considerably more robust than the jugal of a *Varanus* of equal dimensions, and its close proximity to the postorbital in the articulated skull, as shown in Plate 3, Figure 1, leads me to believe that they probably met and formed a complete arch. The posterior extremity is missing so that this important point can not be determined from this specimen. The jugal is strongly curved from end to end, and on the internal side of the anterior half the bone is longitudinally grooved for its contact with the ectopterygoid. The thin sharp edge of the ventral border of the anterior end was interposed between the maxillary and palatine bones below the lachrymal contact. Owing to slight distortion, these bones could not be properly articulated in the restored skull.

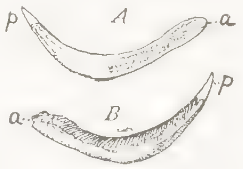

Fig. 41.—Left jugal of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. A, inner view; B, outer view; *a*, anterior end; *b*, posterior end

LOWER JAW

Both rami of the lower mandible are fairly well preserved except for the loss of a small section from the anterior halves of both dentaries. In their general proportions, relative extent of the various elements, and the manner of articulation of the component bones, they closely resemble the rami of *Varanus salvator*, the chief difference noted being the shorter but heavier expanded posterior extension back of the cotylus of the ramus.

Dentary.—Viewed laterally the dentary joins the surangular by a nearly straight vertical suture at a point slightly posterior to the center of the ramus, as in *Varanus*. The union of these two bones, however, is not as weak as it would first appear, as the surangular extends forward for a short distance on the inside of the dentary, thus forming an effective and strong articulation. Dorsally it meets the coronoid and ventrally the small angular, which sends forward a short process that is wedged in between the dentary and the splenial. The latter bone laps along the inner side of the dentary, covering the V-shaped mandibular fossa of that side.

Viewed from the side the dentary narrows toward the front. Near its posterior end it is perforated by a large oval foramen, as in *Varanus*. Smaller foramina at intervals form a row immediately below and parallel to the dental border. (See A, fig. 42.) The upper internal side of the dentary presents a beveled surface on which the expanded bases of the pleurodont teeth are attached. This surface slopes downward from the outer alveolar border of the jaw and gradually increases in width from the posterior end to the point where the bone is broken off.

The anterior ends of both dentaries were found when the last preparatory work was done on the specimen and these are shown to be much more slender than in *Varanus* of equal size. There is a very weak symphysial union of the two rami.

Surangular.—The surangular is the largest bone of the posterior half of the ramus and forms the greater part of the external view of this portion of the jaw. (See A, fig. 42.) Posteriorly it has a pointed extremity which ends posterior to the cotylus of the jaw. Ventrally the posterior half of this bone unites by a horizontal suture with the underlying articular prearticular, the anterior half with the smaller angular. The anterior end is truncated, passing 5 millimeters inside the posterior end of the dentary. On the anterior, superior, and lateral surfaces depressions in the bone distinctly mark the depth of overlap of the dentary. On the superior anterior border a grooved surface marks the seat of the coronoid bone, which is detached. The posterior end of the surangular is transversely expanded and contributes slightly to the formation of the anterior border of the cotylus for the articulation of the quadrate. On the inside of the jaw the surangular meets the prearticular by a horizontal suture somewhat below the middle of the ramus and continues forward to their contact with the overlying splenial. The right surangular has a greatest length of 53.3 millimeters.

Angular.—The angular is a small, pointed bone that underlies the surangular externally and the forward extension of the prearticular internally. (See A, fig. 42.) As in the living Monitor, a slender, pointed process continues forward, being intercalated between the splenial and dentary slightly in advance of the vertical surangular-dentary suture. On the anterior internal side it is overlapped by a posterior projection of the splenial.

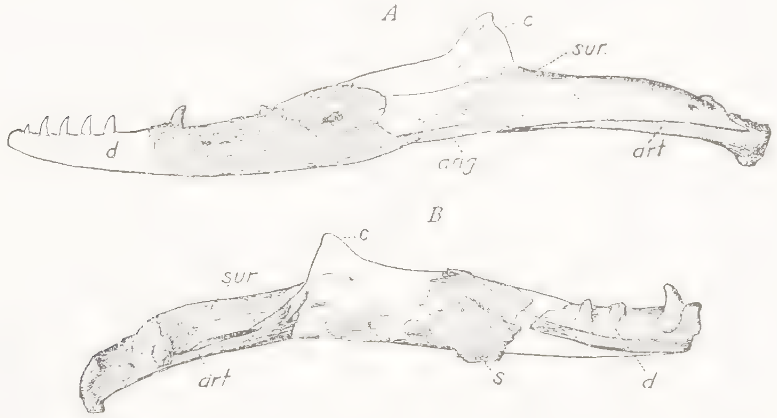

Fig. 42.—Left ramus of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. A, outer view; B, inner view; *ang*, angular; *art.* articular; *c*, coronoid; *d*, dentary; *s*, splenial; *sur*, surangular. Anterior end of dentary restored after *Varanus*

Articular-prearticular.—The so-called articular in the lizards is considered by Williston[82] to be the articular-prearticular complex. There is no indication of a suture in this specimen to show which part of this complex is articular and which is the prearticular portion. As a matter of convenience in describing this part of the ramus, that part of the complex lying in front of the cotylus will be arbitrarily considered the prearticular portion, and the posterior part, including the cotylus, the articular portion.

The articular-prearticular complex is an elongate bone that forms the whole of the lower boundary of the ramus posterior to the angular and all of the extension of the jaw behind, including the cotylus. (See fig. 42.) The prearticular portion extends forward beneath the surangular to meet the angular, where it passes from a lateral view, but internally it continues forward, the anterior end being intercalated between the splenial and dentary. Posteriorly it forms the ventral margin of the posterior inframeckelian foramen. In front of this foramen in *Varanus* the prearticular is in contact with the coronoid, and it is presumed that a similar condition would prevail in the completely articulated *Saniwa* ramus.

The articular portion of this ramus, from a dorsal view, presents a wide cotylus, shallowly concave anteroposteriorly, behind which the articular is slightly contracted, the truncated end being enlarged, this latter expansion being especially pronounced in a ventral-internal direction. This posterior extension differs from *Varanus* in being shorter, relatively heavier, and in the development of a hooklike internal-ventral expansion of this end. This pointed posterior extremity of the surangular laps along the upper external side, ending about midway between the center of the cotylus and the posterior end of the ramus.

Splenial.—Although only the thin, vertically expanded posterior portion of the left splenial is preserved (see B, fig. 42), an examination of the dentary along which this bone laps on the inner side shows that in shape and extent anteriorly it is approximately the same as in *Varanus*. It covers the inner side of the Meckelian groove on the dentary and extends posteriorly, overlapping the anterior ends of the surangular, prearticular, and angular. It appears also to have been in contact with the coronoid.

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[82] Journ. Geol., vol. 22, 1914, p. 411.

Coronoid.—The right coronoid was found detached from the rest of the jaw and in a fair state of preservation. It is a small bone, curved from end to end, deeply grooved on the ventral side, which sets astride of the striated superior border of the surangular. The inner process that extends down to meet the prearticular is missing. Anteriorly, when articulated, it was in contact with the dentary and splenial as in *Varanus*.

The resemblance of the joint between the dentary and the posterior portion of the ramus to the mosasaurian ramus has long been noticed as one of the important characters indicating relationship between these two groups. A careful comparison fails to show that *Saniwa* is nearer to *Mosasaurus* in this respect than is the living *Varanus*.

Measurements

	Mm.
Greatest length of ramus from posterior end to anterior end of surangular	56. 5
Greatest length from forward border of cotylus to end of angle	11. 0
Greatest depth of ramus forward of cotylus	7. 4
Greatest depth posterior to surangular-dentary suture	10. 0
Greatest transverse width of expanded end of angle	7. 5
Greatest transverse width of cotylus	7. 6
Greatest length of angular (about)	24. 7
Estimated length of ramus	100. 7
Depth at symphysial end of dentary	1. 8

TEETH

The teeth of *Saniwa ensidens* are pleurodont. Of this specimen 65 are preserved, wholly or in part, distributed in the jaws as follows: Posterior portion of the right maxillary contains five of the six posterior teeth of the series, in addition to two stumps more anterior, probably the ninth and tenth, counting from the back; anterior portion of the same maxillary bears a series of eight anterior teeth; the posterior part of the left maxillary contains the basal portions of four teeth; the anterior part a series of five; the premaxillary the full complement of six; the left dentary two posterior teeth and a series of 11 in the anterior extremity; the right dentary has the three posterior teeth of the series, the fifth from the back, and a series of 10 in the anterior extremity. Four teeth were found detached in the matrix and the basal portions of three others are shown in a broken fragment whose position in the series could not be determined.

The largest preserved in the median part of the dental series are sharply pointed, curved slightly backward like the saber-shaped fangs of *Varanus*, compressed from side to side, with trenchant borders fore and aft. As in *Varanus* the bases of all the teeth, but more especially the posterior two-thirds of the series, are dilated and ankylosed by their bases to the oblique roughened surface of the jawbones. (See pl. 7, fig. 3.) The dilated basal portions of the teeth are characteristically striated. Owen observes that the striations in *Varanus* are "produced by inflected folds of the external cement, as in *Ichthyosaurus* and *Labyrinthodon*, but they are short and straight as in the former genus." [83]

In the right maxillary six teeth occupy a space of 21.7 millimeters; in the anterior end of this same bone six teeth occupy a space of only 5 millimeters. These anterior teeth are crowded close to one another and have rounded crowns with subacute apices. The opposing teeth of the dentaries and maxillaries appear to be indistinguishable.

The premaxillary series consists of six small subcylindrical teeth of about equal size, whose crowns are incurved. They occupy a space of 5.2 millimeters, and, except for their slightly smaller size, closely resemble those of *Varanus salvator*. Apparently there was not a median azygous incisor in *Saniwa*.

In the right maxillary there is evidence of 21 teeth, and it is estimated that not less than 3 would be required to fill the gap between the posterior and anterior parts of the series as now preserved. Thus in the complete maxillary there were not less than 24 teeth. In the parts of the left dentary present there is evidence of 17 teeth, and it would appear that at least 5 would be required to complete the series, making 22 in all.

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[83] Owen, R., Anatomy of Vertebrates, 1866, vol. 1, p. 404.

The dental formula of *Saniwa* may be tentatively stated as:

$$\frac{\text{premaxillary } 6,\ \text{maxillaries } 48+}{\text{dentaries } 44+}=\frac{54}{44}$$

In *Varanus* the dental formula varies considerably with the different species, but none closely approaches *Saniwa*. *Varanus niloticus* has a dental formula of $\frac{30}{22}$, *V. bengalensis* $\frac{30}{24}$, *V. salvator* $\frac{30}{24}$, and *V. griseus* only $\frac{18}{14}$. It will therefore be observed that the greater number of teeth in *Saniwa* constitutes an important difference for separating the genus from *Varanus*.

There is no evidence of the number of successive teeth or the manner of their replacement, though there can be but little hesitation in saying that the latter must have been as in *Varanus*.

VERTEBRAE

The vertebral column is now represented by 41 fairly well preserved vertebrae and fragments of at least two more, making 43 in all. Twenty-one of these may be classed as presacral (see pl. 5), the remaining 22 as caudal. The presacral vertebrae were preserved in three short series. The first, commencing with the complete atlas, consists of the first six in the column (see fig. 41) and a remnant of the centrum of the seventh, all articulated. The next block contains four articulated anterior dorsals with a fragment of the fifth. The remaining 10 form the third articulated series. Some of these were slightly disarranged in the matrix, but it is thought that they constitute a continuous series. In mounting the skeleton these three series were regarded as being continuous from the skull back to the twenty-first vertebra. Since the living *Varanus* has 29 presacrals, it appears reasonable to suppose that *Saniwa* had an equal number. Thus there would be but seven vertebrae missing from the presacral region, and these between the twenty-first and the sacrum.

The anterior caudal vertebrae present were also preserved in three separate blocks of matrix. Of the 16 caudals from the anterior part of the tail, 12 are regarded as forming a continuous series from the second to the thirteenth, inclusive, a gap of two and an articulated series of four. The remaining five are from near the distal end of the tail and, except in their small size, give no clue to their exact position in the series.

Atlas.—The atlas is almost perfectly preserved and was but little disturbed from its proper relation with the axis. It consists of the strongly keeled intercentrum, odontoid, and the two lateral neuropophyses, as shown in Figure 43. The centrum of the altas (odontoid) is suturally united with the axis, and, as in most reptiles, its place is taken by the octogenous hypapophysis or intercentrum. It presents a cupped articular surface for the basioccipital and a similar surface behind for the odontoid. The base of each neurapophysis has an antero-internal articular surface that contributes to the formation of the cupped end for the reception of the occipital condyle, a middle surface for union with the neuropophysis, and a postero-internal surface for the upper and lateral part of the odontoid. Above this articular end the neuropophysis is constricted fore and aft, above which it is widely expanded and arches over the neural canal, meeting on the median line without coalescing. There is no neural spine. Each neuropophysis develops from its upper and hinder border short zygapophyses which articulate with the axis. From its posterior side below a shorter diapophysis is developed.

The odontoid is wider than high and presents a convex face in front which completes the articular cavity for the occipital condyle; below is the surface for the intercentrum and above and behind it are the two articular surfaces for the neuropophyses. The whole posterior part is sutured to the centrum of the axis and in part ankylosed to its hypapophysis.

Axis.—The centrum of the axis is nearly 13 millimeters in length. Much of the spinous process is lacking. The forward part is thin and overhangs the odontoid. On the neural arch there is no trace of a diapophysis. On either side of the neural arch in front are articular surfaces representing the prezygapophyses, and on the posterior end the transversely expanded neural arch develops well-defined postzygapophyses. The centrum, as in all varanids, terminates in a ball behind. Below this ball it sends downward and backward a heavy exogenous process with a cupped end which looks downward and backward for the articulation of the hypapophysis which is missing. (See *h*, fig. 43.) This process is the heaviest of the series, whereas in *Varanus salvator* they grow progressively heavier from the axis back to the sixth cervical, but in *V. griseus* this progression is less pronounced. The cupped articular end for the articulation of the hypapophysis is 5.4 millimeters long and 5 millimeters wide. The lower anterior end of the centrum is deeply incised by a broad V-shaped notch for the articulation of the axis intercentrum. The backwardly projecting talon of the intercentrum is missing, but apparently it was present as in *Varanus*.

Cervical vertebrae posterior to the axis.—Articulated with the axis are the third, fourth, fifth, sixth, and anterior end of the centrum of the seventh vertebrae, counting backward from the skull. (See fig. 43.) The vertebrae of *Saniwa*, as compared with those of *Varanus* having a skull of equal size, are considerably smaller throughout the presacral series, and this applies especially to the cervical vertebrae. The principal changes to be observed in the structure of the vertebrae between the third and seventh are (1) the development on the cervicals of forwardly projecting divergent anterior zygapophyses, which become longer and heavier in each succeeding vertebra back to the sixth of the series; (2) the exogenous process for the hypapophyses, which is largest on the axis, becomes rapidly reduced in size posteriorly, until on the sixth only a vestige remains;[84] (3) the small, transverse process first developed on the third vertebra is decidedly larger on the fourth and increasingly so on each succeeding vertebra, with a change from the almost horizontal position to a diagonal, thus approaching the vertical processes found in the dorsal region. The development of these articular transverse processes is much more rapid than in *Varanus*.

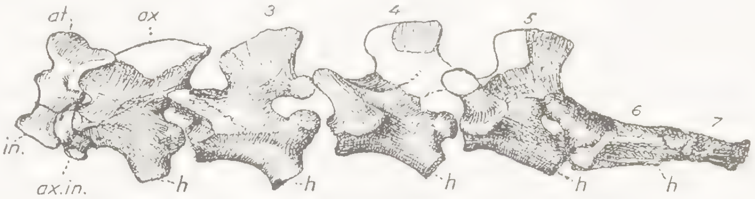

Fig. 43.—Cervical vertebrae of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. Outer view. *at*, atlas; *ax*, axis; *ax. in*, axis intercentrum; *h*, hypapophyses; *in*, intercentrum of atlas; 3, 4, 5, 6, 7, cervicals 3 to 7, respectively

It would thus appear that in *Saniwa* the fifth, possibly the fourth vertebra carried the first rib. That the fifth cervical bore a rib is indicated by the discovery in the matrix of a short cervical rib lying below the diapophyses of that vertebrae. In *Varanus* the first rib is on the seventh cervical. Osborn states[85] that *Tylosaurus* bears "a small rib which is not preserved." Camp[86] observes: "The appearance of the cervical diapophyses in varanoids, however, may be deceptive and the evidence should be conclusive before allowing the mosasaurs an extraordinary number of ribs." The centra in this series are approximately the same length throughout, with a cup in front and ball behind, a feature common to most lizards, and which continues throughout the vertebral column. The ball is oval transversely and its articular face looks strongly upward and backward, being hardly apparent from the ventral view. The neural spines of the cervical series in *Saniwa* are badly damaged, but they do not appear to have been taller in the succeeding dorsals, while in *Varanus* they are higher and wider fore and aft than any that follow them in the presacral series. These spines are thin transversely but anteroposteriorly are wide plates of bone that terminate dorsally with truncated extremities without transverse expansion. The posterior zygapophyses do not protrude beyond the ball of the centrum.

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[84] In skeletons of *Varanus salvator* and *V. griseus*, the hypophysial process is present on the seventh cervical with a vestige on the eighth.

[85] Memoirs Amer. Mus. Nat. Hist., vol. 1, pt. 4, 1899, p. 179.

[86] Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p. 360.

Zygosphenes are more rudimentary than in the succeeding dorsal vertebrae. As the talon for the hypapophysis subsides the median ventral keel elongates, as shown in Plate 5, C. The principal dimensions of the cervicals are given in the table of measurements, page 71.

Dorsal vertebrae.—The second series of four articulated vertebrae (see pl. 5) are the eighth, ninth, tenth, and eleventh of the column, enumerated from the skull, the seventh cervical being represented by an anterior portion of the centrum (see fig. 43) articulated with the sixth cervical and a fragment of the neural arch found in the matrix anterior to the eighth. That these four vertebrae form a continuous series with the cervicals previously described is indicated by the presence on the ventral surface of the ninth and tenth of a slight but diminishing median keel, and its absence on the eleventh; also by the progressive but rapid shortening of the space between the top of the diapophysis and the anterior zygapophysis, which leads to a higher elevation of the diapophysis and completes its transition from diagonal to vertical, a position that persists throughout the remainder of the presacral series. These changes coincide precisely with those observed in the transition of vertebrae in the column of *Varanus*.

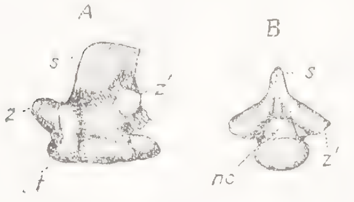

Fig. 44. Dorsal vertebra of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. A, viewed from the left side; B, viewed from posterior end; *nc*, neural canal; *s*, spinous process; *t*, transverse process; *z*, anterior zygapophysis; *z'*, posterior zygapophysis

The third series of articulated dorsals consists of 10 vertebrae which are regarded as being continuous with those described above, thus representing the twelfth to the twenty-first inclusive. (See pl. 5.) All of the dorsals posterior to the tenth resemble one another so closely in their principal characteristics that a description of one will very nearly do for all. Viewed ventrally the centra are subtriangular in outline, with widely expanded articular condyles that are set off by a waistlike constriction of the centra. On the periphery of the flattened articular surface of the condyle a sharp flange is developed and the surface itself turns upward and backward to such an extent as to be invisible from a direct ventral view. The ventral surfaces of the eighth and ninth are flattened, with a low, diminishing keel which has disappeared on the tenth; a few of the succeeding vertebrae remain flattened but this condition gradually changes to a weak transverse convexity. The centra of the anterior half of the rib-bearing vertebrae are shortest, gradually lengthening toward the last of the series. The breadth increases likewise. Viewed from the side the vertebrae widen from the front backward, the top of the neural arches being inclined forward. A prominent rounded ridge extends posteriorly from the base of the diapophysis, merging into the centrum at the constriction. Between this lower ridge and the less prominent one connecting the anterior and posterior zygapophyses, the sides are shallowly hollowed out, this concave area widening from the front toward the back. Anteriorly the diapophysis stands out prominently from the side and is supported about equally by the neurapophysis and centrum, though nowhere is there a trace of the neuracentral suture. The costal facet for the rib presents a hemispherical articular surface and is placed at about the center of the vertically elongated process. In front of the costal facet the heavy support for the prezygapophysis extends upward and forward. The upper articular face of the zygapophysis is large and looks upward and inward.

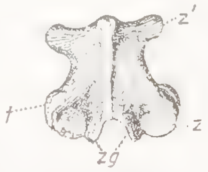

Fig. 45. Dorsal vertebra of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. Viewed from above. *t*, transverse process; *z*, anterior zygapophysis; *z'*, posterior zygapophysis; *zg*, zygantra

The upper surface of the broad neural arch between the anterior zygapophyses is somewhat concave and is traversed longitudinally by a median elevation that develops on its anterior margin two flattened, forwardly projecting processes between which, on the median line, is a broad notch. I regard these processes as rudimentary zygosphenes. (See *zg*, fig. 45.) Marsh noted a similar articulation on the dorsal vertebrae of *Thinosaurus paucidens*. The absence of zygantra, however, shows that they no longer function as a true zygosphene-zygantrum articulation. The posterior half of the upper surface of the neural arch is convex and expands outward posteriorly to form the posterior zygapophyses (see fig. 44B), the articular surface of which looks downward and outward. The median part of the arch develops a wide, thin spine of moderate height which thickens posteriorly, especially in its upper extremity. The posterior part of the arch, including the zygapophyses, overhangs the centrum but terminates forward of its most posterior extension. When viewed from above, the posterior zygapophyses with the connecting arch form a nearly straight transverse line, whereas in *Varanus* it is widely V-shaped, this feature, together with the presence of rudimentary zygosphenes I regard as the most striking differences to be observed between the vertebrae of *Saniwa* and *Varanus*. The median top of the arch connecting the anterior and posterior zygapophyses is deeply but widely incised, as is well shown in Figure 45. The arch on either side of the base of the spinous process is more steeply inclined than in the *Varanus* dorsals, thus giving them a more massive appearance. The transverse width of the zygapophyses, as well as the width of the whole arch, increases gradually from the front to the posterior part of the series, as is shown by the table of measurements below. The anterior articular concavity or cup is a transverse ellipse, obliquely placed, that looks downward and forward.

I have carefully compared this series of dorsal vertebrae with those of *Varanus griseus* and *V. salvator*, and with the exception of the development of rudimentary zygosphenes and the less marked precondylar constriction in the fossil form, fail to discover any outstanding differences in either shape or proportion. Camp speaks of the dorsal vertebrae of *Saniwa* as "resembling recent *Varanus* but not so short * * *; condyles not relatively as broad as in Varanidae." When compared vertebra for vertebra in the column, I fail to detect the differences noted. It is quite possible that Camp was misled by comparing vertebrae from different parts of the column which would give the differences he mentions, as may be observed by reference to the table of measurements.

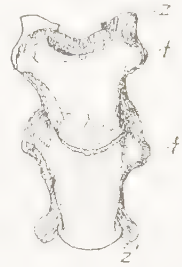

FIG. 46.—Dorsal vertebrae (nos. 12 and 13, pl. 5) of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. Viewed from below. *t*, transverse process; *z*, anterior zygapophysis; *z'*, posterior zygapophysis

Measurements of cervical and dorsal vertebrae of Saniwa ensidens Leidy, No. 2185, United States National Museum

Position in series	Axis	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
Greatest length of centrum at center ventral side	13	15	14.6	14	13.4	-----	-----	12.3	12.2	12	12	11.6	12	12	12	11.6	12	12.8	12	12.6
Greatest breadth across zygapophyses	9.4	-----	14.5	15	15	-----	-----	17	16.5	16.4	16	16	17	17.5	18.3	-----	19	19.5	19	19.1
Least breadth across precondylar constriction	4	5	5	5.4	5.5	-----	6	6.4	6.6	6.7	7	7.3	7	7	7	7.5	7.6	8	8	7.8
Greatest transverse diameter of condyle	-----	7	6.5	7	-----	-----	6.7	-----	7	7.3	-----	7.6	8.2	8.2	-----	8.5	8.6	8.6	-----	8.5
Greatest vertical diameter of condyle	-----	[illegible]	3.3		3.5	-----	3.3	-----	[illegible]	[illegible]	-----	[illegible]	3.7	3.7	3.6	3.7	3.7	3.8	-----	3.9
Greatest transverse diameter across anterior zygapophyses	-----	13.5	13.5	-----	13.5	-----	-----	14.3	14.5	14.6	-----	14.6	14.8	15.5	15.7	-----	16.6	16.8	16.7	16.8
Greatest height over all	-----	19.6	-----	18	-----	-----	16.4	-----	15.1	15.8	-----	15.8	-----	-----	-----	-----	-----	-----	-----	-----
Width of articular surface for hypophyses	5	4	3.4	3	1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Length of articular surface of hypophyses	5	1.8	3.4	2					-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Sacral vertebrae.—The sacral vertebrae are missing in the type specimen but are present in the type of *Thinosaurus leptodus* Marsh (=*Saniwa ensidens* Leidy), and it is upon these that the following description is based.

The two sacral vertebrae are firmly ankylosed as shown in Plate 7, Figure 2. Their centra are short, the two measuring 18.6 millimeters in length. The first sacral is especially broad on the ventral surface, due to the presence of heavy diapophyses that are developed well back and down on the side of the centrum. At the center is a pit and lateral to it are deep, transverse grooves that run outward on the lower sides of the diapophyses, the outer ends of which are missing. The second sacral, seen from below, though short assumes more the general shape of the preceding dorsals, the diapophyses being confined more to the anterior end and higher in position on the centrum. The diapophyses are also wanting but their broken ends show them to be considerably less robust than in sacral one. The zygapophyses are also coalesced, their greatest expanse (13 millimeters) being somewhat less than any of the presacrals accompanying this specimen. The spinous processes are missing but the broken base of this process on sacral one indicates that it was narrower fore and aft than in the dorsal region. The principal features of the sacrals are well shown in Plate 7, Figure 2.

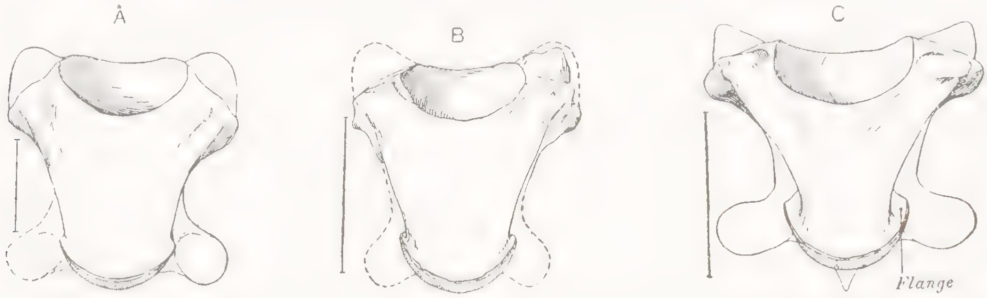

FIG. 47. Dorsal vertebrae of (A) *Saniwa ensidens* Leidy (No. 6056, Amer. Mus. Nat. Hist.); (B) *Saniwa crassa* (Marsh) (No. 6057, Amer. Mus. Nat. Hist.); (C) *Varanus niloticus* (Linn.). For comparison. Viewed from below. (After Camp)

Caudal vertebrae.—There are now 22 caudal vertebrae present with the type specimen, of which 16 are from the anterior half of the tail. In the articulated skeleton 12 of these are placed as a continuous series from the second to the thirteenth inclusive. Difference in size, however, indicates a gap, probably of two, between the thirteenth and the last articulated series of four. This arrangement must be regarded as tentative as the damaged condition of many of the vertebrae precludes the determination of their precise position in the series. That at least one caudal is missing between the most anterior and the last sacral is shown by the presence of chevron facets, whereas these are absent on the first caudal.

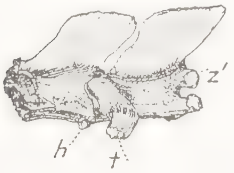

FIG. 48.—Anterior caudal vertebrae of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. Viewed from left side. *h*, hypophysis for articulation with chevron; *t*, transverse process; *z′*, posterior zygapophysis

These vertebrae were preserved in three separate blocks of matrix. Caudals 2 and 3 [87] were found articulated in one block; 6 to 12, inclusive, in a second block; and 16 to 19, inclusive, in the third. The others were disarticulated but not far removed in the matrix from the articulated series in block 2.

The caudal vertebrae retain the depressed cup and ball articulation found in the presacral series; the centra are also more elongate. Viewed ventrally they are tapering but with a less decided precondylar constriction. On the posterior third of the ventral surface of the centrum a pair of short articular protuberances indicate the point of attachment for the chevron. (See fig. 49.) The middle ventral surface is traversed longitudinally by a shallow depression, being less decidedly marked than in the caudals of *Varanus salvator*. Narrow tranverse processes are present on all of these anterior caudals, though none are complete; they are developed on the anterior fourth and well down on the side of the centra, as contrasted with the much higher position in *Varanus*.

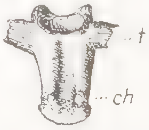

FIG. 49.—Anterior caudal vertebra of *Saniwa ensidens* Leidy. Type (No. 2185, U. S. Nat. Mus.) Natural size. Viewed from below. *ch*, articulation for chevron; *t*, incomplete transverse process

Zygapophyses are short and stout; no evidence of a zygosphene. Several of the vertebrae have the spinous process preserved intact. (See pl. 8.) These, however, indicate one important difference when compared with the tail of *Varanus*—that is, the low, broad (anteroposteriorly) spinous processes of the presacral region continue back in the caudal series. Though they do gradually increase in height posteriorly, they never attained the great elevation found in the living Monitor, *Varanus salvator*. Nor do any of the vertebrae show a fore and aft narrowing of this process, such as begins to take place in the third vertebrae back of the sacrum in *Varanus*. It is therefore apparent that the tail in *Saniwa* never assumed the compressed shape of the semiaquatic *V. salvator*. The absence of caudal vertebrae having high spinous processes suggests that *Saniwa* was a terrestrial form, having a rounded rather than a transversely flattened tail. The dissection of a specimen of *Varanus griseus* from Egypt, a strictly terrestrial form, shows that the spinous processes do not increase so rapidly in height from the sacrum backward as in *V. salvator*, but they resemble that species in being narrow fore and aft.

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[87] These are serial numbers counting backward from the sacrum and are used for convenience of reference.

Attention should be called to the striking similarity between the wide, short spines of *Saniwa* and those of the Mosasauria, another point of resemblance between these groups.

Measurements of caudal vertebrae of Saniwa ensidens Leidy, No. 2185, United States National Museum

Tentative position in series from sacrum	2	3	4	5	6	7	8	9	10	11	12	13	16	17	18	19
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
Greatest length of centrum at center ventral side	12.8	------	12.8	12	------	12.3	11.5	12	12	12.2	------	13	12	11.6	11.6	------
Vertical diameter of ball	3.8	------	3.2	2.9	------	3.5	------	3.3	------	3	------	3.3	3	3	3	------
Greatest transverse diameter of ball	7.3	------	6.6	6.5	------	6.4	------	6	------	6.7	------	7	6	5.8	5.8	------
Greatest transverse diameter across anterior zygapophyses	11	10	9.5	9.4	9.2	9.4	10	9.9	------	10	10	10	9	8	------	8
Greatest height over all	------	------	------	15.8	------	------	15.8	16.5	16.1	16.4	------	------	------	------	15	15

In attempting to find distinguishing characters in isolated vertebrae, especially in studying European material of the genus *Varanus*, the differences in proportion have been much used, particularly the length as related to the breadth of the centrum. The vertebral column of *Saniwa ensidens* clearly shows that these proportions vary with the position in the column, and thus the application has but little significance unless one can be positively sure of the position of the vertebra in the series, a most difficult matter with disassociated vertebrae. With few exceptions the vertebrae in the lizards so closely resemble one another as to render a close identification as to position in the column almost out of the question.

Ribs.—In the three blocks of matrix containing the presacral vertebrae, there are parts of more than 18 ribs (see pl. 8, fig. 2), several being nearly complete. All of the ribs are single headed. One lying near the right coracoid has a vertically expanded head, indicating that it belongs to the posterior cervical series, the expansion of the head corresponding to the elongation of the parapophyses in this region of the neck. The thoracic ribs, however, do not have any appreciable enlargement of the proximal end, which is cupped for articulation with the hemispherical parapophyses of the dorsal vertebrae. The proximal half of the larger thoracic is flattened both fore and aft, becoming subcylindrical as the distal end is approached, which is slightly expanded. These, and in fact all of the ribs, appear to be moderately but regularly curved from end to end. A short curved rib with a wide expanded head was found in the matrix underneath the fifth cervical vertebra and is regarded as belonging to the right side of that bone. It tapers rapidly to a bluntly rounded end and has a greatest length of 14 millimeters. The ribs preserved are well shown in the restoration of the skeleton (pl. 8), where, in their placement, an articulated skeleton of *Varanus salvator* has been used as a guide.

PECTORAL GIRDLE AND FORE LIMB

Coracoid.—The pectoral girdle is represented by the right coracoid and the median portion of the interclavicle, which lay in the matrix at the proximal end of the humerus of that side, and opposite the ninth and tenth vertebrae of the series. It is a broadly expanded bone having a single deep notch on the anterior border as contrasted with the two deep notches in the *Varanus* coracoid. Between the posterior border of this notch and the glenoid border the bone is perforated by a large coracoid foramen. The pointed posterior projection is much more produced and pointed than in *Varanus*. (Compare figs. 50 and 51.) The precoracoidal process has suffered the loss of its articular end and has the anterior extremity of the coracoid internal to the notch. In the presence of a single notch and the long, sweeping convex curve of its inner border, this bone resembles the coracoid of the inguanid lizard *Laemanctus longipes*, as figured by Parker.[88] Cope states: "There are two coracoid emarginations in most Iguania, exceptions being the terrestrial genera *Urocentrum, Sceloporus* and *Phrynosoma* and the Anolidae. There are also two in Varanidae and Teiidae. The Agamidae generally have but one, but *Uromastrix* is an exception. There is but one in the Anguidae and Scincidae (two in *Tiliqua*) and none in Helodermidae and Chamaeleonidae."

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[88] Reynolds, S. H., The Vertebrate Skeleton, 1897, p. 286, fig. 54.

The presence of a single emargination in this early varanid is also of interest in showing another point in common between this group and the Mosasauridae. The coracoid is much thickened dorsoventrally at the border of the glenoid cavity. The ventral surface is slightly convex anteroposteriorly as in the Monitor. The coracoid measures 15 millimeters in width from the glenoid border to the inner edge; as preserved it measures 17 millimeters anteroposteriorly. The notch, at its widest expanse, measures 6 millimeters across.

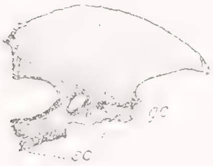

Fig. 50.—Left coracoid of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. Outer view. *gc*, coracoid contribution to the glenoid fossa; *sc*, border that articulates with the scapula

Interclavicle.—The median portion of the anterior part of the interclavicle shows it to have the anchorshape of other varanids, being more rounded than angular. Unfortunately the median longitudinal bar as well as the outer ends of the transverse processes are missing. It differs from *Varanus* in having a small, pointed anterior projection at the center. The principal features of this fragmentary bone are well shown in Plate 4, Figure 2.

Humerus.—The right humerus is present and in a fair state of preservation. Some portions of the anterior side of the distal half of the shaft and the condylar articular surface for the radius on the distal end are missing. Compared with the corresponding element in a skeleton of *Varanus salvator*, it agrees very closely in general form except for the more abrupt expansion of the ulnar side of the distal end the apparent reduction in extent of the thin, sharp ridge on the radial or outer border. This ridge is perforated by a foramen for the radial nerve. The ridge appears to have been restricted in height and also in the distance it extended upward on the shaft of the bone, as contrasted with the humerus of *Varanus*. (See fig. 52.) In the abrupt outward expansion of the ulnar border of the distal end, this bone more nearly resembles the humerus of *Iguana tuberculata*. In *V. salvator* the same expansion is achieved, but by a gradual curve outward, beginning higher up on the shaft of the bone. *V. sivalensis*, as figured by Falconer,[89] is intermediate in respect to the contour of this end of the humerus. The shaft is nearly straight and subcylindrical, as in most other lacertilians, with a large medullary cavity. The transversely expanded distal end has two condyles; the one for articulation with the radius, however, is missing in this specimen. The proximal articular head is transversely elongated, being suboval in outline. The radial crest projects from the shaft at some distance below the head of the bone.

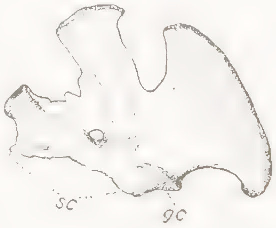

Fig. 51.—Left coracoid of *Varanus salvator* Laur. (No. 29551, U. S. Nat. Mus.) Natural size. Outer view. *gc*, glenoid cavity; *sc*, scapular articulation

Comparative measurements of humeri

	Saniwa ensidens No. 2185 U. S. National Museum	*Varanus salvator* No. 25551 U. S. National Museum
	Mm.	*Mm.*
Greatest length	54. 0	68. 0
Greatest width, proximal end	19. 0	24. 5
Greatest width, distal end	17. 5	23. 0
Least diameter of shaft	5. 0	6. 0

PELVIC ARCH AND HIND LIMB

Pelvis.—The right ilium of the type of *Thinosaurus leptodus* Marsh (No. 612, Yale Museum), articulated with the proximal ends of the pubis and ischium, furnishes the first information concerning the pelvic girdle in *Saniwa*. In all general characteristics it closely resembles the pelvis in the existing *Varanus*. The ilium is complete except for the small pointed process that is given off in front of the sacro-iliac syndesmosis, which is missing. That such a process was originally present is clearly shown by fractured surfaces on both ilia of this specimen. The ilium is produced backward from the acetabular portion as a slender, tapering bar that is terminated with a pointed end in contrast to the heavy, obtuse end in *Varanus salvator*, and it is also much more compressed transversely. It has the upward inflection in relation to the sacrum so characteristic of the Sauria in general. At the forward end the heavy acetabular portion turns downward and joins about equally with the ischium and pubis to form the acetabular cavity. (See pl. 7, fig. 1a.) The ischium is produced backward. Below the proximal end the shaft is constricted anteroposteriorly but immediately expands into a wide, thin blade, most of which is missing in this specimen, as shown in Plate 7, Figure 1. At the center of the acetabulum the ischium meets the posterior border of the pubis by a vertical suture. Only the heavy articular end of the pubis remains. It is perforated near its acetabular end by the obturator foramen. The pubis is fractured through the foramen in this specimen so that it is not known whether a pectineal process was present or not, though from the fact that it occurs in *Varanus*, it probably is also present in *Saniwa*.

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[89] Paleontological Memoirs, vol. 1, 1888, pl. 32.

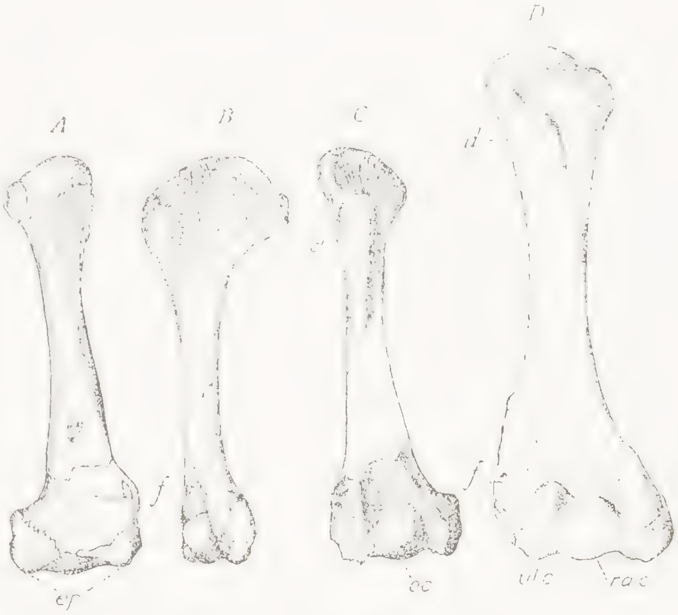

FIG. 52.—A, B, C, Left humerus of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) A, superior view; B, oblique inferior view; C, viewed from below; D, left humerus of *Varanus salvator* Laur. (No. 29551, U. S. Nat. Mus.), viewed from below. *d*, deltoid crest; *ep*, epiphysis; *f*, foramen; *oc*, condyle for radius; *ra.c*, radial condyle; *ul.c*, ulnar condyle. All natural size

Femur.—The distal end of the left femur and the proximal half of the tibia of the same side represent all that is preserved of the posterior limb of the type specimen. Excepting its slightly smaller size and less prominence of the ridge developed on the internal anterior sides which continues down to the distal end, this portion of the femur is very similar to the corresponding bone in the *Varanus* skeleton. The principal features of the distal portion of the femur are well shown in Figure 53, and in Plate 6, Figures 7 and 7a. The articular surface, which is well toward the posterior side, is broadly concave transversely. On the anterior side, external to the center of the bone, is a well defined groove which extends for a short distance up on the shaft of the bone. The epiphysis of the distal end of this bone is as distinctly defined as in the living *Varanus*. The broken end of the shaft shows a large medullary cavity, now filled with calcite. The transverse diameter measures 13.2 millimeters; the fore and aft diameter at the center is 8.5 millimeters.

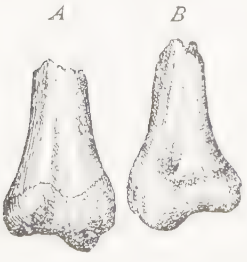

FIG. 53.—Distal end of right femur of *Saniwa ensidens* Leidy. Type. (No. 2185, U. S. Nat. Mus.) Natural size. A, view from above; B, view from below

In Plate 7, Figures 4, 4a, and 4b, are shown the right femur, lacking the distal articular end, of the specimen on which *Thinosaurus leptodus* Marsh was based, and a nearly perfect left femur of a specimen in the United States National Museum (No. 4119), both of which are regarded as pertaining to *Saniwa ensidens*. These give a good conception of the complete bone. I have compared these femora with those of *Varanus salvator* and *V. griseus* and, except in size, found no differences that could be considered of specific importance. They have the same curvature; the same angulation between proxima and distal ends; a distinct head that is oval in section; a strong trochanter that is distinctly set off at a right angle to the head on the inferior anterior side.

Measurements of femora

	Type No. 2185, U. S. National Museum	No. 612, Yale Museum	No. 4119, U. S. National Museum
	Mm.	*Mm.*	*Mm.*
Greatest diameter of head		12. 0	11. 0
Greatest transverse diameter of head		6. 1	6. 0
Greatest transverse diameter across trochanter		12. 5	11. 5
Greatest transverse diameter of distal end	13. 2		12. 2
Greatest diameter fore and aft at center	8. 1		6. 8
Least diameter of shaft		5. 3	5. 5
Length over all			58. 7

Tibia.—The proximal half of the left tibia (see pl. 6, figs. 1, 1a) shows the same broad expansion of the upper end with flattened anterior surface, and the same contracted subtriangular shaft at the middle with large medullary cavity as in the living Monitor. In fact, I fail to find any characters by which it may be distinguished from the tibia of *Varanus*. The proximal end of the tibia has a greatest transverse width of 13 millimeters.

Phalangials.—In Plate 7, Figures 2 and 3, are shown two phalangial bones regarded as pertaining to the hind feet, as shown in the restored skeleton. (See pl. 8.) These appear indistinguishable from the corresponding bones in the pes of *Varanus*, with which they have been carefully compared.

REFERRED SPECIMENS

In addition to the type, the following specimens have been identified as belonging to *Saniwa ensidens*.

No. 612, Yale Museum. This, the type of Marsh's *Thinosaurus leptodus*, consists of the anterior portion of a right dentary with basal portions of two teeth; 13 dorsal, 2 sacral, and 3 or more caudal vertebrae; right ilium, ischium, and pubis, the last two lacking their distal extremities; left ilium and ischium in part; femur lacking distal end; various fragments of vertebrae and other bones. Bridger formation (horizon B), Middle Eocene, Grizzly Buttes, Uinta County, Wyo. Collected by J. F. Quigley, September 2, 1871.

No. 613, Yale Museum. This, the second specimen mentioned by Marsh in his original description of *T. leptodus*, consists of 5 or more dorsal, 2 sacral, and 25 or more caudal vertebrae; proximal end of left femur; distal ends of both femora; proximal ends of both tibiae; parts of fibulae; left astragalus; proximal end of left humerus; proximal portions of the ilium, ischium, and pubis; articular ends of several phalangial bones. Bridger formation (horizon B), Middle Eocene, Grizzly Buttes, Uinta County, Wyo. Collected by G. G. Lobdell, jr., September 2, 1871.

No. 1064, Yale Museum. Consists of 10 dorsal vertebrae. Bridger formation (horizon B), Middle Eocene, Grizzly Buttes, Uinta County, Wyo. Collected by Yale expedition of 1870.

No. 1070, Yale Museum. Consists of many fragmentary dorsal and caudal vertebrae, parts of pelvic arch, proximal half of tibia, proximal end of humerus, etc. Geological occurrence unknown. Collected by S. Smith, March 29, 1876, north of P. Mass Ranch.

No. 6056, American Museum of Natural History. Consists of numerous fragmentary caudal and dorsal vertebrae and a calcaneum. Bridger formation (lower level), Middle Eocene, Dry Creek, Uinta County, Wyo. Collected by Walter Granger, June 4, 1903.

No. 4119, United States National Museum. Consists of the right femur, one cervical, three dorsal, and seven caudal vertebrae, with numerous fragments. Bridger formation, Middle Eocene, Bitter Creek, near Mammoth Buttes, Uinta County, Wyo. Collected by E. D. Cope, August 12, 1872.

No. 4128, United States National Museum. Consists of 12 dorsal vertebrae and numerous fragments. Bridger formation, Middle Eocene, Black's Fork, Uinta County, Wyo. Collected by E. D. Cope, July 28, 1872.

No. 5169, American Museum of Natural History. An articulated series of 11 dorsal vertebrae, 2 sacrals articulated with 10 anterior caudals; a second articulated series of 9 median caudals and 17 scattered caudal vertebrae. Numerous limb and foot bones, with most of the articular extremities lacking. Wasatch, Eocene, 3 miles southeast of the mouth of Pat O'Harra Creek, Clark's Fork Basin, Wyo. Collected by American Museum expedition of 1912. Provisionally referred.

SANIWA PAUCIDENS (Marsh)

(Pl. 9, figs. 7, 8, 9)

Thinosaurus paucidens Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 299.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 476.

Saniwa paucidens (Marsh), Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 60, 1922, p. 25.

Type specimen.—Yale University Museum, but temporarily misplaced. Consists of the "greater part of a skeleton." Collected by O. C. Marsh, September, 1872.

Type locality.—Grizzly Buttes, Uinta County, Wyo.

Horizon.—Horizon B, Bridger formation, Middle Eocene.

Original description.—The present species is based upon the greater part of a skeleton found, by the writer, in place. Portions of several other skeletons were discovered in the same region by other members of the Yale party. In the former specimen, the teeth were not numerous, but appear to have been long and sharp. The bases of the crowns attached to the inner wall of the jaw are much expanded, and their sides furrowed, as in *Heloderma*. The dorsal vertebrae have the articular ball and cup transversely elliptical, and much inclined. The centra have their inferior surface very slightly concave longitudinally, and convex transversely. The articular faces for attachment of the ribs have a round tubercle on their upper portion. The sacral vertebrae are short, and are quite concave below longitudinally. They have no ridge between the zygantial cavities as in the preceding vertebrae. The anterior and median caudals are elongated, but less so than the dorsals. The distal caudal vertebrae are slender, but not materially compressed. The limb bones preserved resemble those of the Iguanas. The remains preserved indicate an animal about 4 feet in length.

Measurements

	Mm.
Space occupied by 3 lower teeth	13. 0
Length of dorsal vertebra from edge of cup to end of ball	16. 0
Width of articular cup	11. 0
Width of ball	10. 2
Expanse of anterior zygapophyses	19. 0
Expanse of posterior zygapophyses	17. 0
Expanse of small intermediate processes	4. 5
Length of first sacral vertebra	13. 0
Width of cup	8. 6
Length of first caudal	13. 2

The type specimen on which the genus and species *Thinosaurus paucidens* was established can no longer be located among the Yale collections, although it may be found when these materials, now largely in temporary storage, can be more thoroughly overhauled. The brief description and measurements of the type given by Marsh are sufficient, however, to show it to be congeneric with the genus *Saniwa*.

This specimen is coequal in size with the type of *Saniwa crassa* (Marsh), and I find in the brief description given above only one character which would appear to distinguish the two species. I refer to the "inferior surface very slightly concave longitudinally and convex transversely," as contrasted with the perfectly flat longitudinal surface and flat or slightly concave transverse aspect of the dorsal vertebrae in *S. crassa*. In all other respects the original description, except for the large size of the specimen, would apply equally well to the other species of the genus. In the articulated vertebral column of *S. ensidens* a few of the anterior dorsals have inferior flattened surfaces, while those that follow are moderately convex transversely as in the present species. Mention is made of this feature in order to call attention to the possibility that the differences noted above may occur in different sections of the same vertebral column. In the event of that being the case with the two species under consideration, *S. crassa* would become a synonym of *S. paucidens*. The considerably larger size of the latter, however, will serve for the present to distinguish it from both *S. agilis* and *S. ensidens*, and the absence of a shelflike inflection on the vestigal zygosphenes would separate in from *S. grandis*.

A specimen in the Carnegie Museum collection (No. 3278) has no less than 22 of the presacral centra present. (See pl. 9, figs. 7, 8, 9.) All of these, excepting one or two, have transversely convex haemal surfaces, and since the proportions of the vertebrae are in close agreement with the measurements of the type, I refer the specimen to *S. paucidens*. If my identification is correct, the greater precondylar constriction would be an additional difference for distinguishing the dorsal vertebrae of *S. paucidens* from those of *S. crassa*. This difference is clearly shown by comparison of Figure 8, Plate 9, and Figure 6, Plate 10.

REFERRED SPECIMENS

No. 3278, Carnegie Museum. Consists of 2 fragmentary cervical vertebrae, 12 fairly perfect presacral vertebrae, and portions of at least 10 others; 2 sacral vertebrae, somewhat broken; 6 anterior caudal vertebrae in series; numerous fragmentary parts of vertebrae, limb bones, etc. From horizon B or C, "gray beds below red and gray beds of horizon B," Uinta formation, Upper Eocene, Uinta Basin, Uinta County, Utah. Collected by Earl Douglass and J. T. Gochschine, 1908.

SANIWA GRANDIS (Marsh)

(Pl. 10, figs. 1 to 5)

Thinosaurus grandis Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 301.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 476.

Saniwa grandis (Marsh) Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 60, 1922, p. 25.

Type specimen.—Yale University Museum, catalogue No. 611. Consists of a dorsal vertebra lacking the condylar end; first and second caudal vertebrae; left ilium; pubis and ischium, lacking much of their distal extremities; proximal portion of right pubis which is suturally united with a fragment of the ilium. Collected by C. W. Betts, September, 1870.

Type locality.—Grizzly Buttes, Uinta County, Wyo.

Horizon.—Horizon B, Bridger formation, Middle Eocene.

Original description.—A gigantic lizard, the largest yet discovered in the Green River Basin, and exceeding in size any living species, is indicated by fragmentary portions of several individuals. These remains agree so nearly with those of the species above described [*S. crassa*] that they may be referred, provisionally at least, to the genus *Thinosaurus*. The vertebrae, so far as known, resemble in their proportions those of *T. crassus*, but the dorsals have the centra convex transversely on the inferior surface. The rudimentary zygosphene, moreover, in the type specimen of the present species, has its sides inflected, forming a shelf beneath the cavities thus inclosed, a peculiarity not seen in the vertebrae of the other species of the genus. The posterior sacral vertebra has a groove on the lower side of its diapophyses. This species was probably not less than 7 feet in length, and three or four times the bulk of *Iguana tuberculata*.

Measurements

	Mm.
Transverse diameter of cup of dorsal vertebra	13. 0
Transverse diameter of same vertebra between articular faces of diapophyses	29. 0
Transverse diameter of neural arch between zygapophyses	16. 0
Expanse of posterior zygapophyses	22. 0
Length of posterior sacral [first caudal] vertebra	18. 0
Transverse diameter of ball	11. 5
Length of first [second] caudal vertebra	18. 1
Anteroposterior diameter of acetabular cavity	21. 0

Marsh's brief description given above covers all of the essential peculiarities of the fragmentary type. Further preparation of this specimen disclosed the presence of the acetabular, portions of the left ilium, ischium, and pubis, and the proximal portion of the right pubis with a small piece of the ilium attached. Except for the larger size of these bones, they are indistinguishable from the homologous elements of *Saniwa ensidens*. Longitudinally the acetabulum measures 23.3 millimeters across, while that of the latter species is only 13.5 millimeters.

The vertebra regarded by Marsh as a posterior sacral proves on comparison with an articulated skeleton of *Varanus* to be the first caudal (see pl. 10, figs. 1, 2), as shown by the presence of rudimentary chevron attachments and also by the distinctive transverse process which develops a deep groove on the anterior edge, that deepens as the outer end of the process is approached. A foramen leads through from this groove to the groove on the lower median surface of the transverse process.

On the anterior caudal, probably the first, a vestige of the rudimentary zygosphene is present in the form of two very small projecting points. (See pl. 10, fig. 2.) The single dorsal vertebra present in the type lacks the condylar end of the centrum (see pl. 10, fig. 3), the neural spine, the prezygapophysis and diapophysis of the left side, and the right posterior zygapophysis. The importance of this bone lies in the fact that it carries the one feature, aside from its large size, which appears to distinguish this species from the others of the genus. Reference is made to the medial inflection of the zygosphenes forming shelves beneath the cavities thus inclosed. (See zg., pl. 10, fig. 4.) This peculiar type of zygosphene has been found in only one other specimen, No. 1646, American Museum of Natural History, a considerably smaller individual. While Marsh was probably right in regarding it to be a distinctive feature of this species, nevertheless I wish to call attention to the possibility of its being a feature peculiar to the posterior part of the vertebral column in *Saniwa,* and that after all it is not characteristic of a single species. However, since a complete presacral series is unknown at this time, the merit of this suggestion can not certainly be ascertained, and for the present it appears best to continue the species, distinguishing it from other North American varanid lizards by its peculiar type of zygosphene, the strong transverse convexity of the posterior inferior surface of the dorsals, massiveness of the vertebrae, and the very large size of the individual. There is a vestige of the zygantrum to be observed, but it is so reduced as to no longer function as an additional articulation of the vertebra, and similar vestigial zygantra are found in *Saniwa ensidens* with its different type of zygosphene. The zygosphene in *S. grandis* is relatively larger and more prominently developed than in the gigantic *Megalania prisca* of Australia, and the presence of "strongly developed *zygosphene* and *zygantrum*" were regarded by Fejérváry as one of the important family characters,[90] though their importance was apparently stressed by him, since in the description of the vertebrae he says "well marked though relatively small zygosphenes." An inspection of the figures would indicate a zygosphene even more reduced than those found in *Saniwa ensidens.*

A first caudal vertebra from the same locality as the type specimen No. 1075, Yale Museum, was identified by Marsh as pertaining to the same species, and the correctness of this identification is fully confirmed by a comparison with its homologue of the type, with which it agrees in every particular.

Among the lacertilian remains lent to me by the American Museum of Natural History is a fragmentary specimen consisting of eight dorsal vertebrae, the majority of which have the characteristic inflection of the zygosphene so typical of this species. This feature and the strong transverse convexity of the ventral surfaces of the centra seem sufficient for the reference of this specimen to *S. grandis,* although the vertebrae belong to an individual considerably smaller than the type specimen. The distal end of a large left femur, also in the collection of the American Museum of Natural History, is clearly identifiable as belonging in the genus and is provisionally referred to this species. It has a greatest transverse diameter of 15.5 millimeters and a greatest anteroposterior diameter of 11 millimeters. These specimens are of further interest as extending the geological range of the species downward into the Wind River formation.

REFERRED SPECIMENS

No. 1075, Yale Museum. A first caudal vertebra. From the Bridger formation, Middle Eocene, Uinta County, Wyo. Collected by O. C. Marsh September 5, 1871.

No. 1646, American Museum of Natural History. Eight dorsal vertebrae. Wind River formation, Middle Eocene, Alkali Creek (Buck Springs), Fremont County, Wyo. Collected by William Stein August 21, 1909.

No. 1647, American Museum of Natural History. Distal end of left femur. Locality and horizon same as preceding. Collected by Walter Granger, 1909. Provisionally referred.

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[90] Ann. Mus. Nat. Hungarici, vol. 16, 1918, p. 449.

Saniwa crassa (Marsh)

(Pl. 10, figs. 6 to 10)

Thinosaurus crassus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 301.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 476.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 47.

Saniwa crassa (Marsh) Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 60, 1922, p. 25.

Saniva major, Leidy, J. (in part), Rep. U. S. Geol. Surv. Terr., vol. 1, 1873, pp. 182, 345, pl. 15, fig. 14, pl. 27, figs. 36, 37.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 46.—Fejérváry, G. J., Ann. Mus. Nat. Hungarici, vol. 16, 1918, pp. 420, 422, fig. 20.

Saniwa major Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475. -Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 60, 1922, p. 22.

Type specimen.—Yale University Museum, catalogue No. 610. Consists of five fairly perfect dorsal vertebrae, a few fragmentary parts of vertebrae, and the shaft of a right humerus. Collected by O. C. Marsh September 12, 1871.

Type locality.—Near Henry's Fork, Uinta County, Wyo.

Horizon.—Horizon C or higher, Bridger formation, Middle Eocene.

Original description.—A third and still larger species of the same genus is represented in our Wyoming collections by a number of dorsal vertebrae and a few other less characteristic remains, all parts of one skeleton. The vertebrae preserved differ considerably from those of the preceding species in being much more massive in proportion to their length, which is about the same as in *T. paucidens.* Those of the dorsal series have the inferior surface of the centrum nearly straight longitudinally and flat or slightly concave transversely. The unarticular surface of the vertebrae is everywhere irregularly striated. The known remains of this species indicate a reptile about 5 feet in length.

Measurements

	Mm.
Length of dorsal vertebra on lower surface	16. 0
Transverse diameter of articular cup	11. 2
Transverse diameter of ball	11. 0
Vertical diameter	5. 5
Expanse of anterior zygapophyses	22. 0
Expanse of posterior zygapophyses	20. 2

Saniwa crassa was established by Marsh on five dorsal vertebrae and the shaft of a humerus, though no mention is made of the latter in the original description. The shaft of the right humerus, in so far as it can be compared, is more quadrangular in cross section at its mid length than the humerus of either *Saniwa ensidens* or the living *Varanus salvator.* A skeleton of the latter now before me measures 1,450 millimeters, or about 57 inches in length, and the larger size of the fossil humerus would indicate that the estimated length of 5 feet for the extinct form would be considerably short of its true proportions.

The varanid affinities of the species are at once indicated by the dorsal vertebrae with depressed, tapering centra with expanded, flanged condylar ends whose articular surfaces are invisible from a direct ventral view. (See pl. 10, fig. 6.) In size they are about the same as those of the type of *S. paucidens*, but their longitudinally flattened haemal surfaces, which are flat or slightly concave transversely, and their more massive proportions, with less marked precondylar constriction, appear to distinguish *S. crassa* from all of the other species of the genus with the exception of *S. major* Leidy, which I consider conspecific. The latter species was founded by Leidy on the distal end of a humerus and two dorsal vertebrae from the Bridger formation of Wyoming. The humerus, as Fejérváry first recognized,[91] does not belong to the Reptilia, and has since been made the type of an extinct species of owl by Wetmore.[92]

The two vertebrae can no longer be found in the Philadelphia Academy of Sciences where they were supposed to have been preserved, but from Leidy's figures (see pl. 11, figs. 2, 2a), description, and measurements it is found that they are almost identical in size and other characteristics with those forming the type of the present species, and as *S. crassa* has priority by a year *S. major* must therefore be regarded as a synonym.

In the straight transverse outline of the neural arch, across the posterior zygapophyses and in the development of the vestigial zygosphene processes the dorsals of *S. crassa* closely resemble those of *S. ensidens.* In these and other respects the affinities of this species appear to be closest to *S. paucidens.* The possibility that more perfectly preserved specimens may show the present species to be the same as *S. paucidens* is fully discussed under that species. (See p. 77.)

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[91] Ann. Mus. Nat. Hungarici, vol. 16, 1918, p. 421.

[92] Proc. Acad. Nat. Sci. Philadelphia, vol. 73, pt. 3, Apr. 6, 1921, p. 455.

Measurements of the type vertebrae

	1	2	3	4
	Mm.	*Mm.*	*Mm.*	*Mm.*
Greatest length of centra at center	14. 6	14. 0	15. 0	15. 6
Greatest transverse width of ball	9. 0	10. 1	10. 5	10. 8
Greatest transverse width across costal facets	21. 0	21. 3	21. 7	22. 0
Least transverse width at constriction	8. 5	9. 0	9. 0	9. 6

REFERRED SPECIMENS

Among the lacertilian remains assembled for this study I find nine specimens, in addition to the type, which are identified as pertaining to the present species.

No. 1059, Yale Museum. A fragment of a dentary with basal portions of two teeth; numerous fragmentary dorsal and caudal vertebrae; first sacral with one transverse process; rib fragments; greater portions of both ilia; fragmentary parts of ischium and pubis; portions of various limb and foot bones. Horizon C or higher, Bridger formation, Middle Eocene, Henry's Fork, Uinta County, Wyo. Collected by G. M. Keasbey September 22, 1871.

No. 1071, Yale Museum. Nine dorsal, 1 sacral, and 12 caudal vertebrae and numerous fragmentary portions; fragmentary parts of pelvic, limb, and foot bones. Horizon C or higher, Bridger formation, Middle Eocene, Henry's Fork Divide, Uinta County, Wyo. Collected by O. C. Marsh September 22, 1871. This specimen was originally identified by Marsh as *S. paucidens,* but the flatness of the inferior surfaces of the centra in the two dorsals present leads me to the conclusion that it may be best referred to *S. crassa.*

No. 6057, American Museum of Natural History. Numerous fragmentary dorsal vertebrae; sacral centrum; two caudal vertebrae; fragmentary parts of limb and pelvic bones. Horizon C or higher, Bridger formation, Middle Eocene, Henry's Fork, "Lone Tree," Uinta County, Wyo. Collected by L. S. Quackenbush September 5, 1903.

No. 3273, Carnegie Museum. Several broken dorsal vertebrae and numerous fragments. Horizon B or C, Uinta formation (gray beds below red and gray beds), Upper Eocene, Uinta Basin, Devil's Playground, southeast of Kennedy's Hole, east of stage road, Uinta County, Wyo. Collected by Earl Douglass August 11, 1908.

No. 11227, Princeton University. A poorly preserved articulated series of six dorsal vertebrae with numerous fragmentary parts; right ischium and portions of other pelvic bones, all articulated; right femur. Upper B or Lower C, Uinta formation, Upper Eocene, mouth of White River, Uinta County, Utah. Collected by J. B. Hatcher 1895.

No. 1069, Yale Museum. Poorly preserved dorsal and caudal vertebrae. Horizon unknown, probably B or C, Uinta formation, Upper Eocene, mouth of White River, Uinta County, Utah. Collected by Chew and Forchey 1877.

No. 6057, American Museum of Natural History. Twelve dorsals, 18 caudals, mostly broken; fragments of pelvic bones; ends of femur and tibia; and both calcanea. Horizon C, Bridger formation, Middle Eocene, Dry Creek, Uinta County, Wyo. Collected by Walter Granger June 4, 1903.

Saniwa agilis (Marsh)

(Pl. 9, figs. 1 to 6)

Thinosaurus agilis Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 302.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 476.—Nopcsa, F. B., Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 47.

Saniwa agilis (Marsh) Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 60, 1922, p. 25.

Type specimen.—Yale University Museum, catalogue No. 609. Consists of a fragment of the dentary carrying the basal portion of one tooth; two dorsal vertebrae; one anterior and two posterior caudal vertebrae; distal end of left femur; and a distal phalanx. Collected by G. G. Lobdell, jr., September 23, 1871.

Type locality.—Near Henry's Fork, Uinta County, Wyo.

Horizon.—Horizon C or higher, Bridger formation, Middle Eocene.

Original description.—The smallest species of the genus yet discovered is represented in our collection by some characteristic parts of one skeleton in perfect preservation and by several isolated vertebrae from the same locality. In the former specimen the lower teeth are very similar to those of *T. leptodus*, the next larger species, but the basal grooves on the inner side do not extend up so far on the crown. The two species may be readily distinguished also, aside from the great difference in size, by the anterior caudal vertebrae which in the present specimen have the articular cup much more depressed. In the dorsal vertebrae the neural spine is quite short. The middle and distal caudals are much elongated. The remains preserved indicate an animal about 2 feet in length.

Measurements

	Mm.
Length of dorsal vertebra on lower surface	10.3
Width of articular cup	5.5
Width of ball	5.0
Expanse of anterior zygapophyses	9.0
Expanse of posterior zygapophyses	8.2
Length of first caudal vertebra	7.3
Width of articular cup	5.0
Vertical diameter of cup	2.8
Transverse diameter of distal end of femur	8.0

It will be observed from the list of bones comprising the type specimen that this species was originally founded on very scanty materials. A careful examination and comparison of the original remains indicate beyond question the affinities of the species to be with the genus *Saniwa*, while its small size at once distinguishes it from the other species of the genus.

The fragment of a dentary, to which is attached the basal portion of a single tooth, except for its much smaller size agrees in all particulars with the dentary of *S. ensidens*. The expanded base of the tooth is ankylosed to the oblique surface of the dentary and has the basal surface covered with longitudinal grooves. The extension upward of the grooves on the crown are coequal in extent with those of *S. ensidens*, and I do not consider it an important difference that they are relatively shorter than in *S. leptodus* (=*S. ensidens*), as pointed out by Marsh in his original description, especially since his observation, as is now known, was based on a single tooth.

The two dorsal vertebrae, in addition to their small size, show peculiarities that distinguish them from the other members of the genus. Neither of the two known dorsals have the zygosphenal border completely preserved, so that it is not certainly known whether or not this process was present in this species. The spine, as shown in Plate 9, Figure 4, is low and presumably broad fore and aft, though the anterior portion is missing in the better preserved vertebra.

The low neural spine in *S. agilis* is apparently a distinctive feature of this species. It is relatively lower than in a specimen of *Varanus griseus* of approximately the same size. On this vertebra the top of the spine rises but 3.2 millimeters above the level of the postzygapophyses; in the type of *Saniwa ensidens* the lowest dorsal spine is 7 millimeters in the same measurement.

Viewed from above the posterior outline of the neural arch between the postzygapophyses is moderately excavated (see pl. 9, fig. 3)—that is, the zygapophyses extend backward and outward, which would distinguish the dorsals of *S. agilis* from those of the other species, with their nearly straight transverse outline. In this respect *S. agilis* is intermediate between *S. ensidens*, with its straight outline, and *Varanus*, which is widely V-shaped. The intermediate geological position of the present species is entirely in accord with this development.

The single anterior caudal vertebra preserved is said by Marsh to have the articular cup much depressed. I can not see that it is more depressed than in other species of the genus, nor do I understand why, in the table of measurements, it should be designated as the first caudal when well-developed articular facets for the chevron are present, and an articulated skeleton of *Varanus salvator* now before me shows that the first caudal is nonchevron bearing and therefore devoid of facets on its ventral surface; also, there are no transverse grooves running out on the lower surface of the transverse processes.

The more distal caudals, as in all varanoid lizards, are elongate with the usual pair of articular protuberances for the chevron on the posterior third of their ventral surfaces (see pl. 9, fig. 6), and with a wide longitudinal groove between them that traverses the greater length of the centrum, as in *S. ensidens*.

The single foot bone known of this species, a distal phalanx, is as wide as long, with a slightly keeled proximal end and a shallowly grooved distal extremity. Its greatest length is 3.5 millimeters; its greatest width 3.5 millimeters.

The distal articular end of the left femur is relatively thinner anteroposteriorly than in *S. ensidens*, though it appears that the bone has been somewhat affected by compression in this diameter, especially the shaft portion, which is much flattened fore and aft. Its principal features are well shown in Plate 9, Figures 1 and 5.

While the inadequate nature of the type material is fully recognized, the low dorsal spines, the wide V-shaped outline of the posterior border of the arch, and its small size are regarded as sufficient to distinguish this form, and I therefore continue *Saniwa agilis* as a valid species. It is only by the discovery of additional material that its certain affinities will be disclosed.

SANIWA, species indeterminate

Under this heading are included a few specimens that are clearly referable to the genus *Saniwa*, but whose specific identity can not be certainly determined. These are of interest, however, as coming from formations in which the genus has not previously been recognized or by extending its geographical range.

Specimen No. 10968, United States National Museum, consisting of a single median caudal vertebra (see fig. 54.) is of interest as giving the first evidence of the presence of *Saniwa* in the Oligocene of North America. The expanded condylar ball and chevron facets on the posterior third of the centrum clearly indicate its generic affinities. This specimen is from the White River deposits, Hat Creek Basin, Sioux County, Nebr., and was collected by J. B. Hatcher in 1888.

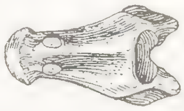

FIG. 54.—Caudal vertebra of *Saniwa* sp. (No. 10968, U. S. Nat. Mus.) Twice natural size. Viewed from below

Specimen No. 5197, American Museum of Natural History, consisting of three imperfect dorsal vertebrae from the "Lower Beds" of the Huerfano formation, Middle Eocene, is the first evidence of the presence of *Saniwa* in that formation. These vertebrae indicate a lizard about the size of the typical *S. ensidens* and may pertain to that species, though their damaged condition renders such a determination uncertain. This specimen was collected in the Huerfano Basin, two miles east of Gardner Buttes, Colorado, by the American Museum Expedition of 1918.

Specimen No. 5180, American Museum of Natural History, consisting of an imperfect dorsal vertebra and other fragmentary bones, extends the geographical range of *Saniwa* into New Mexico, having been collected in the Wasatch, Eocene, near Ojo San Jose, by William Stein in 1912.

Genus PALÆOSANIWA, new genus

Genotype.—Palæosaniwa canadensis, new species.

A little-known genus based on dorsal vertebrae. The tapering form of the centrum with constricted condylar end at once indicates its varanid affinities. While in most particulars the known vertebrae bear a close resemblance to those of the Eocene genus *Saniwa*, they differ in having a decided longitudinal channel on the ventral surface, and this feature, together with its very much earlier geological occurrence, seem to warrant the establishment of a new genus. The meagerness of the type material is fully recognized, but the fact that it represents the most ancient occurrence of an undoubted member of the Sauria yet discovered on the North American continent fully justifies this course of action. It is also of interest to find this genus represented in the Lance formation of Montana, though the evidence as to the material being of the same species as that from the Belly River, is as yet inconclusive.

PALÆOSANIWA CANADENSIS, new species

(Pl. 11, figs. 5, 5a, 5b, 6, 6a)

Lacertian, Gilmore, C. W., Canadian Field Naturalist, vol. 37, No. 3, 1923, p. 52, pl. 4, figs. 2, 3.

Type specimen.—United States National Museum, catalogue No. 10,864. Consists of a nearly complete dorsal vertebra. Collected by W. E. Cutler, 1913.

Type locality.—Near Steveville, Red Deer River, Alberta, Canada.

Horizon.—Belly River formation, Upper Cretaceous.

The vertebra selected as the type of the present species was presented to the United States National Museum by Mr. L. S. Russell, now at the University of Alberta, Edmonton, Canada. It is the second lizard specimen to be found in the Belly River formation, and on that account is of more than passing interest. Except for the loss of the spinous process, the vertebra is well preserved. The tapering form of the centrum, when viewed from below (pl. 11, fig. 5a), together with the constricted condylar end whose articular surface is directed dorsally, shows the vertebra to be typically varanid in character. A median channel-like longitudinal depression that traverses the ventral surface of the centrum (see fig. 55), together with the relatively large zygapophyses, are features distinguishing it from the genus *Saniwa*, and these peculiarities, taken into consideration with the very early geological occurrence of the specimen, are my justification for describing such scanty material as a new genus and species, which I propose to call *Palæosaniwa canadensis.*

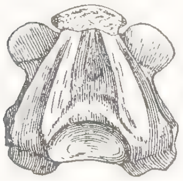

FIG. 55.—Dorsal vertebra of *Palæosaniwa canadensis* Gilmore. Type. (No. 10864, U. S. Nat. Mus.) Natural size. Viewed from below

A second but less complete vertebra (pl. 11, figs. 6, 6a), which, so far as it can be compared, is identical in every respect with the type, is unhesitatingly referred to the same species. It was described in the article cited above as follows:

> A dorsal vertebra, catalogue number 112, University of Alberta, lacking the condylar end of the centrum, the left posterior zygapophysis, and the spinous process shows for the first time the presence of the Belly River fauna of a true lacertian reptile. This specimen was found associated with a miscellaneous lot of materials among which were recognized vertebrae of *Champsosaurus*, a claw of an ornithomimid dinosaur, teeth of a crocodilian, and a tooth and footbone of a small carnivorous dinosaur. This assemblage of fossil bones was collected by Mr. George F. Sternberg, September 29, 1921, at Sandy Point, southwest of Empress, South Saskatchewan River, Alberta, Canada.

The importance of these specimens lies first in showing the presence in the Belly River formation of a true representative of the suborder Sauria, the most ancient occurrence of this group of reptiles yet recorded in North America; second, if correctly identified as to family, in greatly extending the geological range of the Varanidae, which previously has not certainly been known to occur below the Wasatch, Lower Eocene.

It appears from an examination of the specimen in the University of Alberta that vestigial zygosphenes were probably present in undamaged vertebrae, but this point can not be certainly determined in the type specimen. Viewed from above, the posterior outline of the vertebra is nearly straight, not broadly V-shaped, as in *Varanus*. The top of the arch on either side of the spinous process is relatively wider than in species of *Saniwa*, and the lateral incision between the anterior and posterior zygapophyses is not so pronounced. In all other respects the type specimen is identical with the dorsals of *Saniwa crassa*, with which it agrees closely in size.

Measurements

	No. 10864, U. S. National Museum	No. 112, University of Alberta
	Mm.	*Mm.*
Length of vertebra on lower surface	14.5	
Transverse diameter of articular cup	11.0	10.5
Expanse of anterior zygapophyses	24.5	24.5
Expanse of posterior zygapophyses	22.0	22.0
Least breadth across arch at center	16.0	16.0

A third specimen, No. 11,045, United States National Museum, consisting of a single posterior dorsal vertebra, is provisionally assigned to this species. This is larger than those previously described, but it exhibits the same tapering form of centrum with channeled ventral surface. It differs only in size and in having a more elongated centrum, both features which may be accounted for by its more posterior postion in the vertebral column, as is shown by the very much reduced costal facets. In all other respects it closely approximates the type specimen and can certainly be regarded as belonging to the genus, but more complete materials are needed before its specific reference can be regarded as certain. Its chief interest lies in the fact of its coming from the Lance formation of eastern Montana, being the first specimen of its kind to be found in that geological formation. It was collected by W. T. Thom, of the United States Geological Survey, in sec. 28, T. 27 N., R. 49 E., Richland County, Montana, in 1920, and was associated with bones of such characteristic Lance dinosaurian forms as *Thescelosaurus* sp. and *Triceratops* sp.

A fourth specimen, No. 8510, Geological Survey of Canada, consisting of a posterior dorsal vertebra, somewhat extends the range of this little-known genus and species. This specimen was collected by P. S. Warren in 1925 from the "pale beds" of the Belly River series in sec. 2, T. 22, R. 9 W., mouth of Sand Creek, Red Deer River, Alberta, Canada.

PARASANIWA, new genus

Genotype.—*Parasaniwa wyomingensis*, new species.

Characters.—Dentition subpleurodont. Teeth closely placed, with pointed, transversely compressed crowns; erect or slightly recurved; bases slightly dilated with vertically striated surfaces. Known individuals small.

The teeth in their general manner of implantation, with dilated bases having striated surfaces, are typically varanid. They differ by being more closely placed in the jaws, with less dilation of the bases.

Provisionally this genus is referred to the subfamily Saniwinae. Two species are recognized, at this time distinguished as follows:

Key to species

Median teeth of dentary slightly recurved; basal striations extending high on shaft terminating above parapet of dentary	*Parasaniwa wyomingensis.*
Median teeth of dentary erect, basal striations low, terminating below parapet of jaw	*Parasaniwa obtusa.*

All the known specimens are from the Lance formation, Upper Cretaceous, of Wyoming.

PARASANIWA WYOMINGENSIS, new species

(Pl. 26, fig. 11)

Type specimen.—United States National Museum, catalogue No. 10,797. Consists of the median portion of the left dentary containing one complete tooth and the basal parts of two others. Collected by J. B. Hatcher, 1892.

Type locality.—Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

Among the lizard specimens from the Lance formation is a portion of a left dentary that is distinguished by its long pointed, transversely compressed teeth, with bases slightly expanded and more closely placed in the jaw than those of *Saniwa.* The single complete tooth known is slightly recurved with trenchant borders fore and aft. The bases of the teeth are dilated and ankylosed to the oblique surface of the jaw. They rest in suboval depressions, as shown in Figure 56B. The surfaces of the basal portions of the teeth are finely striated, the striae extending high on the shaft. There is a suggestion of vestigial denticles on the anterior and posterior walls. Four teeth occupy a space of 6.7 millimeters. The fragment of dentary has a greatest length of 9 millimeters.

The teeth of *P. wyomingensis* show a striking similarity to those of *Palaeovaranus cayluxi* Filhol, as figured by De Stefano,[93] although they are much more closely placed in the jaw. Resemblances in the structure and implantation of the teeth appear to indicate the varanid affinities of the species.

Parasaniwa obtusa, new species

(Pl. 26, figs. 10, 12)

Type specimen.—United States National Museum, catalogue No. 10,798. Consists of the posterior portion of a right dentary bearing one complete tooth. Collected by J. B. Hatcher.

Type locality.—Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

The posterior portion of a right dentary (see fig. 57) bearing one complete tooth shows differences which appear to indicate the presence of a second species of *Parasaniwa* in the Lance formation, and the name *P. obtusa* is proposed for its reception. It differs from the single complete tooth known of *P. wyomingensis* from the same formation and locality in having an erect crown (not recurved) with an obtusely pointed apex, and with striations restricted to the extreme basal surfaces. The two teeth appear to occupy a closely similar position in the dentaries, as shown by the comparative widths of the underlying Meckelian groove (compare fig. 56 and fig. 57). The complete posterior end of the dentary is well shown in Figure 57B. It is concavely notched, as in the living *Varanus*, but lacks the posterior lateral foramen so prominently developed in that genus. The external face of the crown is flattened, whereas in *P. wyomingensis* it is broadly convex anteroposteriorly. The dentary as preserved has a greatest length of 12.4 millimeters.

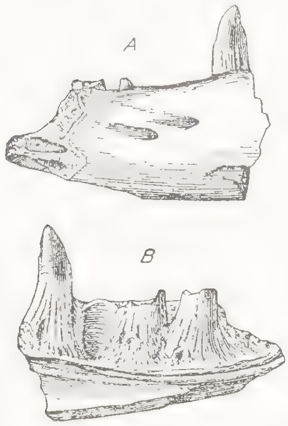

Fig. 56.—Portion of left dentary of *Parasaniwa wyomingensis* Gilmore. Type. (No. 10797, U. S. Nat. Mus.) About five times natural size. A, outer view; B, inner view

A second specimen, No. 10,800, United States National Museum, from the same locality as the type, consisting of the greater portion of a left maxillary and bearing the bases of four teeth (see pl. 26, fig. 10), may be safely referred to this species. The dilated bases have striated surfaces, but, as in the type specimen, these striae are largely confined to the basal portions. The crowns of all four teeth are missing. Five teeth occupy a space of 6.9 millimeters. The external surface of the maxillary has the usual row of foramina parallel to the tooth row. The surface of the bone is smooth except for slightly raised bosses irregularly arranged.

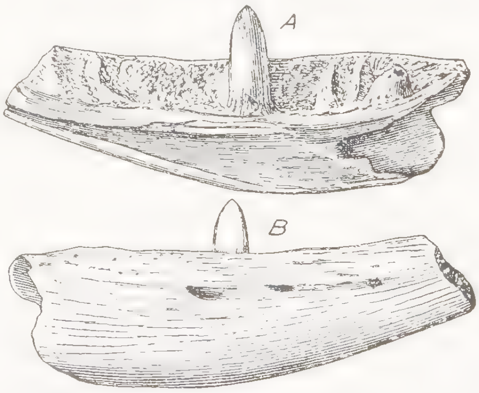

Fig. 57.—Right dentary of *Parasaniwa obtusus* Gilmore. Type. (No. 10798, U. S. Nat. Mus.) About five times natural size. A, inner view; B, outer view

Superfamily MOSASAUROIDEA

Postorbital arch complete; seven cervical vertebrae; centra cylindrical; condylar surfaces directed posteriorly; dentition subthecodont; clavicles and interclavicles greatly reduced or absent; extremities paddle-shaped; digits without claws and with hyperphalangy; sclerotic ring bony.

In a recent paper Dollo [94] recognized three families, which are characterized as follows:

Dentition homodont, cutting; tympanic membraneous; no median basioccipital canal	Mosasauridae.
Dentition homodont, hooked; tympanic ossified; a median basioccipital canal	Plioplatecarpidae.
Dentition heterodont, crushing; tympanic unknown; basioccipital canal unknown	Globidentidae.

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[93] Atti Soc. Ital. Sci. Nat. Mus. Civ. Milano, vol. 42, 1903, pl. 9, fig. 8.

[94] Dollo, L., Archives de Biologie, vol. 34, 1924, pp. 197-199.

The first named includes all of the described American genera, except *Globidens*, and many Old World genera. The Plioplatecarpidae contains only European genera, while the Globidentidae contains the single North American genus *Globidens*.

The systematic position of the mosasaurian reptiles has long been a subject of controversy, the history of which has been fully reviewed by Baur, Williston, Nopcsa, and Dollo. Camp [95] points out:

> Those who have favored varanoid relationships of the mosasaurs and have generally regarded them as something less than a division of the Squamata separate from lizards are: Cuvier, Goldfuss, Owen, Marsh, Baur (1892, 1895, 1896), Merriam (1894), Williston (1898, 1904), Nopcsa (1903, 1908), and Versluys (1907).
>
> Those who have considered varanoid relationships as questionable or distant are: Cope (1869, 1878, 1895*a*, 1895*b*, 1896*a*), Boulenger (1891*a*, 1893), Dollo (1892), Kramberger (1892), Osborn (1899), Fürbringer (1900), Gadow (1901), and Fejérváry (1918).

In Camp's recently proposed classification of the lizards,[96] herewith adopted, the mosasaurs, following Williston, are included in the Sauria as a superfamily of the Platynota, and while it is not my intention to review the evidence in this controversy, or to consider fully the mosasaurian group, it seems advisable to include here characterizations of the superfamily and family in order to indicate their classification within the Sauria. It was decided to omit a revision of the Mosasauridea at this time because of the practical impossibility of assembling the large number of types and other accumulated materials in one institution for study and comparison, and also because of the existence of such a mass of materials that to properly revise the described genera and species would of itself have constituted a work of far greater magnitude than the combined study of all other American Sauria.

Family MOSASAURIDAE

Skull lizardlike, elongate, depressed; superior temporal arcade and pineal foramen present; premaxillae and nasals fused into a simple rostrum; quadrate large perforate; mandibular rami united at the symphysis by ligament, and with a movable articulation behind the middle of each ramus; teeth large and conical, fixed by tumid bases in shallow alveoli of the jawbones and pterygoids; vertebrae procoelous, with or without zygosphene and zygantra; cervicals with hypophyses; sacrum wanting; sternum never fully ossified; limb bones short, digits lengthened by an increased hyperphalangy.

The family Mosasauridae includes the following North American genera:

Clidastes Cope.
Baptosaurus Marsh.
Brachysaurus Williston.
Elliptonodon Emmons.
Diplotomodon Leidy.
Holosaurus Marsh.
Holcodus Gibbes.
Macrosaurus Owen.
Mosasaurus Conyb.
Nectoportheus Cope.
Platecarpus Cope.
Sironectes Cope.
Tylosaurus Marsh.

Camp, quoting from an unpublished manuscript by Williston, who was the most eminent American authority on this group, says:

> Three, perhaps four, adaptive types of mosasaurs are recognized. (Williston, manuscript.) These include: (1) Surface, swimming forms "with elongate trunk composed of as many as 35 dorsals, the tail with pronounced subterminal dilatation, zygosphenes, a well-ossified carpus, and only slight hyperphalangy,"—*Mosasaurus* and *Clidastes*; (2) deep-sea forms "with proportionally shorter neck, less elongated trunk with but 21 vertebrae, a more uniformly flattened tail, less well-ossified carpus and tarsus and greater hyperphalangy,"—*Platecarpus*; (3) "a diving type, with more elongated head, heavy cartilaginous protections for the ears, a relatively short neck, body with but 22 vertebrae, a longer and much flattened tail, almost entirely cartilaginous mesopodials and highly developed hyperphalangy,"—*Tylosaurus*; and (4) possibly a littoral, molluscivorous genus *Globidens* Gilmore (1912), in which teeth were rounded and rugose.

The mosasaurs are at present known from North and South America, Europe, Asia, Africa, and New Zealand, but they probably lived over the greater part of the earth and may be expected wherever Upper Cretaceous deposits are found, to which their geological range is strictly confined.

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[95] Bull. Amer. Mus. Nat. Hist., vol. 48, 1924, p. 323.

[96] Op. cit.

Subsection Diploglossa

Vertebrae of normal procoelus type (except in Pygopodoidea); centra not constricted in front of condyles; no condylar flange; six cervical vertebrae; nasals normal, separate; premaxillaries normal; lower jaw without sutural joint; caudal chevrons usually not pediculate (except in *Glyptosaurus*) and when central usually fused with centrum; osteoderms frequently present; scales imbricate; a parasternum in the Chamaesaurinae.

Superfamily ANGUIOIDEA

Vertebral centra tapering, not constricted; condyles never as wide as the centra; ribs sometimes with a dorsal muscular process; tooth replacement alternate.

Family HELODERMATIDAE

Dentition pleurodont, teeth fanglike, with slightly dilated bases, rather loosely attached to the inner steeply beveled edge of the jaws; teeth grooved on front, some on back; teeth on the pterygoid and palatine bones. Premaxillary single; nasals and frontals double; inferior ridges on frontal inclosing the olfactory lobe; pre- and postfrontals in contact, thus excluding the frontal from the orbital border; a strong postorbital arch; no postfronto-squamosal arch; parietal single, no parietal foramen; pterygoids and palatines widely separated; infraorbital fossa bounded by the pterygoid, palatine, ectopterygoid, and maxillary; head covered with bone tubercles. Clavicle slender, without transverse process; sternum divided longitudinally. Coracoid without emargination. Vertebral centra tapering, rounded transversely; articular ball set off by distinct annular groove; no zygosphene; neural spines relatively low; chevrons attached at posterior end of centrum.

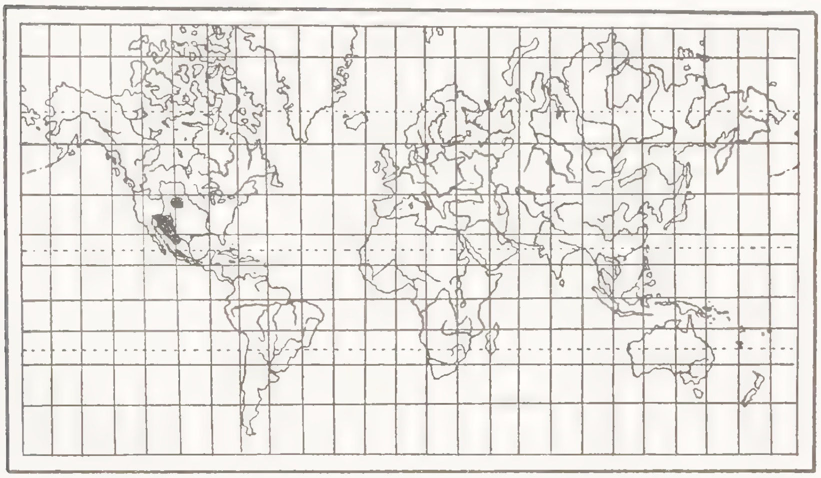

FIG. 58.—Map showing the present and past distribution of the Helodermatidae

This family contains the single genus *Heloderma*, whose range is restricted to the western parts of Central America from the Isthmus of Tehuantepec northward into Mexico. Another species occurs in Arizona, New Mexico, and north into southern Utah. *Heloderma* is the only poisonous lizard known. The living forms inhabit dry localities and spend most of the daytime in concealment, coming out in the evening in search of worms, centipedes, frogs, and the eggs of large lizards.

Several extinct genera have been referred to this family, but upon examination all are found to have their affinities elsewhere. *Helodermoides* of Douglass is shown to be a synonym of *Glyptosaurus* (see p. 92), and thus belongs in the Anguidae. Nopcsa, in 1908, included *Thinosaurus*, *Glyptosaurus*, and *Placosaurus* in this family. *Thinosaurus*, as shown elsewhere, is a varanid lizard and a synonym of *Saniwa; Glyptosaurus* belongs in the Anguidae, and there is every reason for believing that *Placosaurus* has similar family affiliations. From this brief review it is at once apparent that the new species about to be described is the first authentic occurrence of this family in the fossil record.

Genus HELODERMA Wiegmann

Heloderma Wiegmann, Isis, 1829, p. 624.

Genotype.—*Heloderma horridum* Wiegmann.

The characters of the genus are included in those given for the family. Two living species, *Heloderma horridum* and *H. suspectum*, and one extinct species, *H. matthewi*, are now recognized as belonging to this genus.

Heloderma matthewi, new species

(Pl. 11, figs. 1, 1a)

Type specimen.—American Museum of Natural History, catalogue No. 990A. Consists of the posterior portion of a left maxillary bearing three posterior teeth. Collected by W. D. Matthew, 1898.

Type locality.—Lewis Creek, Logan County, Colo.

Horizon.—Oreodon zone, White River formation, Oligocene.

The specimen selected as the type of the present species came into my hands associated with a considerable portion of a right dentary containing teeth which clearly show it to belong to *Peltosaurus granulosus* Cope. The recurved fanglike teeth of the maxillary fragment indicated at once its distinctness from *Peltosaurus*, and a comparison with jaws of *Heloderma horridum* and *H. suspectum* showed such close resemblances, especially in the form and structure of the teeth, as to leave no doubt of their close relationship.

The teeth in the fossil are pleurodont and attached by slightly dilated but very oblique bases. The basal surfaces, as in the living species, are longitudinally grooved on both internal and external sides. The teeth are well spaced and rapidly decrease in size from front to back. The crowns are subconic and recurved. The apices are missing from all of the known teeth, but judging from the regular taper of the preserved portions it can be safely inferred that they were sharply pointed. The anterior face is marked by a deep groove which runs external to the middle line. It is formed by the rolling inward of the external face of the crown over the anterior face of the tooth. This groove is uniformly open from top to bottom instead of being partially closed toward the bottom as in the living species. (See fig. 59.) None of the three maxillary teeth present show evidence of a groove on the posterior face. Three teeth occupy a space of 4 millimeters.

Boulenger, Cope, and others speak of the teeth of the living forms as having grooves on both front and back, but in specimens of these now before me the greater number of the maxillary teeth are without grooves on the posterior side. The small posterior maxillary tooth in all, however, shows a distinct posterior groove, but since this tooth is missing in the type specimen, comparisons can not be made. Most of the dentary teeth of the living species are found to be grooved on both faces.

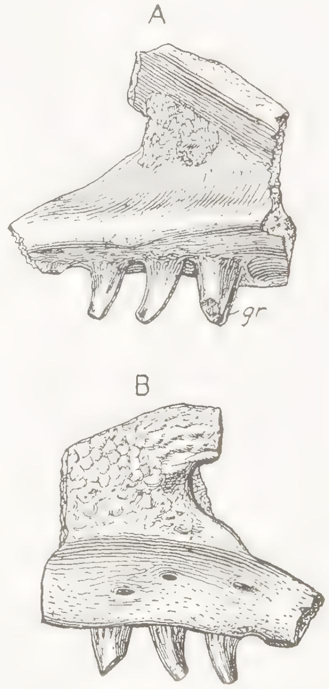

Fig. 59.—Left maxillary of *Heloderma matthewi* Gilmore. Type. (No. 990A, Amer. Mus. Nat. Hist.) About five times natural size. A, inner view; B, outer view; *gr*, anterior groove in tooth

From a lateral view the upper surface of this maxillary fragment is covered by a granular sculpture (see pl. 11, fig. 1) resembling the ornamentation of the cranial bones in *Peltosaurus*. There are no lines of division showing the existence of scutes, but it may be that the scutes have become fully fused with one another as they have with the underlying maxillary. A narrow band paralleling the alveolar border is devoid of sculpture as in the living species. It is perforated by the usual foramina, each of which occupies a position similar to those in the living forms.

The more uniformly open anterior groove on the teeth and the granular ornamentation of the maxillary bone, together with the Oligocene occurrence of the fossil, appear sufficient to characterize this as a new species. The specific name is in honor of my friend Dr. W. D. Matthew who collected the type specimen.

Family ANGUIDAE

Skull of normal lacertilian type, supratemporal fossa roofed over by dermal bones; premaxillary single; parietal single in *Gerrhonotus*, *Peltosaurus*, *Melanosaurus*, and *Glyptosaurus*, double in other genera; inferior frontal plates not surrounding olfactory lobes of the brain; nasals distinct; columelli cranii present; infraorbital vacuity bounded by the palatine, pterygoid, ectopterygoid, and maxillary; pterygoids and palatines well separated along the median line. The palate is either toothless or teeth may be developed on the pterygoids or even on the palatines and vomers (*Ophisaurus* and *Melanosaurus*).

The dentition varies from the strictly pleurodont tubercular teeth of *Ophisaurus apus* and some Diploglossi, through the conical teeth of the majority of species to the curved fangs of *Anguis*. The new teeth do not hollow out the base of the old ones, but originate between them. Osteoderms present, either tuberculate or nontuberculate. Vertebral centra much flattened inferiorly and much like those of the Varanidae. Limbs may be more or less developed, or entirely absent externally, in which case, however, the rudiments of the pectoral and pelvic arches are always present. Clavicle slender; interclavicle, in the species with well developed limbs, cruciform. Abdominal ribs absent.

The body is protected by bony plates underlying the scales, which are rectangular and subequal. These plates are provided with a system of fine tubercles, as in the Scincidae, which differ, except in *Glyptosaurus*, from those of that family in being arranged irregularly or forming radiating or arborescent figures. The head shields present this peculiarity, that an occipital or azygos posterior shield is constantly present, except in *Glyptosaurus*, a character which differentiates the Anguidae from most of the Scincidae.[97]

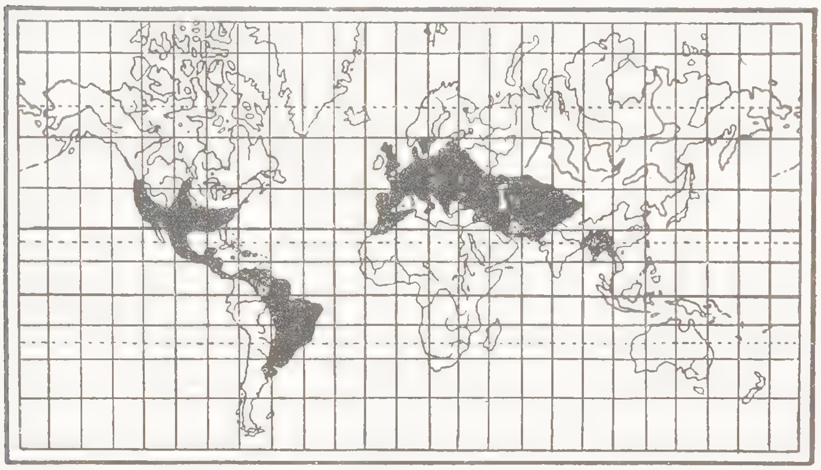

FIG. 60.—Map showing the past and present distribution of the Anguidae. Modified from Gadow

The Anguidae form a group comprising both recent and extinct representatives. The living members of the family are in a very unstable condition, there being a general tendency to reduce and lose the limbs. The shoulder and pelvic girdle, however, remain, although sometimes merely vestigial. The tail is long, very brittle, and easily reproduced. All of these lizards are strictly terrestrial and live on animal diet. One genus, *Anguis*, is ovoviviparous.

The family is most abundantly represented in Central America (*Gerrhonotus*) and the West Indies (*Celestus*); a few species occur in North and South America, two in Europe and on the border of the Mediterranean, and one in the Himalayas and Burma.

Nopcsa, in 1908,[98] referred the following genera of extinct forms to the present family:

EUROPEAN GENERA	NORTH AMERICAN GENERA
Anguis.	Exostinus.
Diploglossus.	Peltosaurus.
Euposaurus.	Xestops.
Proseudopus.	
Pseudopus.	

The North American genera now considered as belonging to the Anguidae are *Peltosaurus* Cope, *Xestops* Cope, *Glyptosaurus* Marsh, and *Melanosaurus* Gilmore.

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[97] The above osteological characterization of the family Anguidae has been largely extracted from Boulenger's *Catalogue of lizards in the British Museum*, vol. 2, 1885, p. 265, with additions and modifications of my own to harmonize the definition for the inclusion of the extinct forms now referred to this family.

[98] Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 49.

The extinct North American members of the family are all confined to the Rocky Mountain region having been found in South Dakota, Wyoming, Utah, Nebraska, Colorado, and New Mexico, in the United States, and in the Cypress Hills, Canada.

European genera referable to the Anguidae include forms from the Miocene, some of which closely resemble *Ophisaurus*, *Propseudopus fraasii* Hilgendorf,[99] described from a complete skeleton taken at Steinheim, being the best known. The skull, teeth, and osteoderms are similar to *Ophisaurus*, and the ribs have a dorsal tuberculumlike process, as in that genus. These two genera are distinguished by the greater number of teeth on the vomers of the fossil specimen. Von Meyer's *Pseudopus* from the *Oligocene* of Bonn, later described under the name *Pseudopus moguntinus* by Boettger,[1] is included. Lartet [2] described species of the genus *Anguis* from Sansan as having teeth like *Ophisaurus*. Gervais [3] redescribed two of Lartet's species. Gerhardt[4] referred a lower jaw with teeth from the Lower Miocene of Ulm to the genus *Ophisaurus*.

The family Anguidae now includes the Glyptosauridae of Marsh. (See p. 93.)

Key to extinct American genera of the Anguidae

Frontals usually separate, moderately excavated between orbits. Interparietal shield never present. Dermal scutes on head subequal in size, ornamented with embossed tubercles. Body scutes usually with low carina but with whole surface tuberculate; strongly sutured laterally. Teeth on pterygoids in patches or two parallel rows. Quadrate with relatively narrow internal wing. Postfrontal and postorbital usually coalesced, latter excluded from border of orbit. Teeth with obtuse compressed crowns, with or without sculpture	*Glyptosaurus.*
Frontals always united, moderately excavated between orbits. Interparietal shield constantly present. Dermal scutes on head having symmetrical arrangement as in recent lizards; with granular ornamentation. Body scutes with or without carina, latter ornamented as rest of scute; sutured laterally. Few teeth on pterygoid in single row. Quadrate with relatively narrow internal wing. Postorbital and postfrontal coalesced. Teeth with obtuse compressed crowns	*Peltosaurus.*
Frontals united, moderately excavated between orbits. Interparietal shield present. Dermal scutes on head usually coalesced, with embossed tubercular ornamentation. Body scutes with or without low carina, ornamented as rest of surface with embossed tubercles, strongly sutured laterally. Teeth in large patches on pterygoids and palatines, few on vomers. Quadrate with broad, thin, semicircular internal wing. Postorbital and postfrontal distinct. Teeth with obtuse compressed crowns	*Melanosaurus.*
Frontals separate, lateral borders between orbits nearly parallel. Interparietal shield unknown. Head scutes much as in *Peltosaurus*, granular ornamentation. Body scutes asymmetrical carinate, carina having smooth, sharp edge, rest of surface granular. Body scutes united laterally by beveled overlap. Teeth on pterygoid in large patch. Quadrate unknown. Teeth with obtuse compressed crowns	*Xestops.*

Genus GLYPTOSAURUS Marsh

Glyptosaurus Marsh, O. C., Amer. Journ. Sci., ser. 3, vol. 1, 1871, p. 456.
Helodermoides, Douglass, Earl, Annals Carnegie Mus., vol. 2, 1903, p. 160.

Genotype.—*Glyptosaurus sylvestris* Marsh.

Characters.—Head and body covered with osteoderms having tubercular ornamentation; head scutes four, five, and six sided, and more or less of equal size; body scutes rectangular, ornamentation usually forming regular pattern, frontals usually separate. Teeth on pterygoids; postorbital excluded from orbital boundary; parietal in contact with squamosal, roofing over part of supratemporal fossa.

Prof. O. C. Marsh, in establishing the genus *Glyptosaurus*, states:

> Among the most interesting reptilian remains discovered by the Yale party in the fresh water Tertiary deposits of western Wyoming were several species of Lacertidae, or land lizards, of which no fossil representative had at that time been found in this country, although more recently one species has been described by Professor Leidy from the same formation. These remains were found associated with the crocodiles and serpents, already

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[99] Zeitschrift. Deutsch. Geol. Gesell., vol. 37, 1885, pp. 358–378.

[1] Paleontopgraphica, Band XXIV, 1876–1877, p. 197.

[2] Ann. du Depart. du Gers, 1851.

[3] Ann. Sci. Nat. (31, XX, 1853).

[4] Jahresber, Vereins Vaterl. Naturkünde Württemberg, 1903, pp. 67–71.

> described, and, together with them, strikingly illustrate the remarkable development of reptilian life during the Tertiary period in one of the great tropical lakes of the Rocky Mountain region.
>
> The specimens discovered evidently represent a peculiar genus of lizards, quite different from any known recent or fossil forms but in the present preliminary notice only the most marked characters are given, the more exact determination and affinities of the group being reserved for the full description. The head in this genus, for which the name *Glyptosaurus* is proposed, was covered with large osseous shields, symmetrically arranged and highly ornamented, resembling in this respect the modern *Heloderma*. Other parts of the body, especially the ventral region, were protected by rectangular, ornamented shields, united to each other by suture, and, in some of the species, these were carinate. The teeth are pleurodont, and, in the species in which they are preserved are round, with obtuse summits, not unlike those of *Trachydosaurus rugosus* Gray from Australia. The frontals show, especially in front, a distinct median suture, which forms a slightly obtuse angle with their posterior margin. The articular bone projects behind the cotylus far backward and downward, resembling in this respect the corresponding part in *Varanus niloticus*.
>
> The dorsal and caudal vertebrae have the same general form as those of *Varanus*, but show traces of a zygosphene articulation, especially in their rudimentary zygantral cavities. The tail was long and apparently rounded. Some of the species were larger than any existing American lizards.

In a later publication [5] Marsh supplements his original description as follows:

> In addition to the characters given when the genus *Glyptosaurus* was proposed, the following, derived from a study of more complete specimens, may be mentioned. The entire body and tail were covered with ornamented osseous plates, most of them united by suture. The rami of the lower jaw were but loosely attached at the symphysis. There were numerous small teeth, "*dents en cardes*," on the pterygoids. The malar arch was complete. The parietals were thick, and there was a parietal foramen. The pelvic arch and the limb bones resemble those in the Iguanas, but the posterior limbs were proportionally smaller. The caudal vertebrae, in some species at least, were divided transversely by a thin unossified septum, so that the centra break there readily, as in many recent lizards. This genus and its allies evidently represent a distinct family, which may be called *Glyptosauridae*.

There has been a great diversity of opinion as to the family affinities of the genus *Glyptosaurus*, and, until recently, no one has accepted Marsh's proposed family Glyptosauridae. Zittel [6] was apparently the first paleontologist to definitely assign *Glyptosaurus* to the Anguidae, an assignment which the present study fully confirms. He was also probably correct in regarding *Placosaurus* Gervais as a member of that family, and it would not be at all surprising if, when better specimens are known, it is found that *Placosaurus* and *Glyptosaurus* are congeneric, in which case *Glyptosaurus* would become a synonym of *Placosaurus*, which has priority by several years. Boulenger [7] suggested that *Glyptosaurus* has its closest affinities with *Heloderma*, and, apparently acting upon this suggestion, Nopcsa [8] referred the genus to the Helodermatidae. Camp,[9] however, the latest authority to deal with the problem, proposes to reestablish Marsh's Glyptosauridae to include the genera *Glyptosaurus* Marsh, *Xestops* Cope (for *Oreosaurus* Marsh preoccupied), *Peltosaurus* Cope, *Helodermoides* Douglass, and probably *Placosaurus* Gervais. At the same time he points out characters in this group which establish distinctions of family rank between it and the Helodermatidae, as follows:

(1) Presence of a supratemporal arch and fenestra.
(2) Separation of prefrontal and postfrontal above orbit.
(3) Postfrontal and postorbital entirely distinct.
(4) Pediculate caudal chevrons on the centra.
(5) A pineal foramen (very small in *Xestops*, absent in *Peltosaurus*).
(6) Imbricating osteoderms on the body.
(7) Teeth on the pterygoid, palatine, and prevomerine bones.
(8) Parietals united by suture (fused in *Peltosaurus*).
(9) Transverse processes of first caudal vertebra arising from the entire length of the centrum as in *Gerrhonotus*.
(10) Jugal with an angular process.
(11) Frontals fused (separate in *Helodermoides*?).
(12) Teeth highly pleurodont with cylindrical, solid shafts and blunt, highly wrinkled crowns, as in some Anguidae.

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[5] Amer. Journ. Sci., 3d ser., vol. 3, 1872, p. 6.

[6] Handb. der Pal., vol. 3, 1890, p. 608.

[7] Proc. Zool. Soc. London, 1891, p. 116.

[8] Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, pp. 40, 49.

[9] Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p.. 328.

I can not confirm the statement that the parietals are united by suture, as none of the available specimens shows a trace of a parietal suture; also, the pineal foramen is unknown in *Xestops* and is present in *Peltosaurus*. It should further be noted that the vertical plates on the ventral side of the frontals in *Glyptosaurus* do not meet on the median line to inclose the olfactory lobe of the brain as they do in *Heloderma*. These characters effectually dispose of any reason for regarding *Glyptosaurus* as having its affinities with the Helodermatidae. I can not subscribe to Camp's argument for the reestablishment of the family Glyptosauridae, neither can I indorse his statement that that group is intermediate between the Anguidae and Helodermatidae. His distinctions for the separation of the Glyptosauridae from the Anguidae are as follows:

(1) The great extent of the patches of teeth on the pterygoids and palatines.
(2) The massive rectangular jugal, somewhat as in *Heloderma*.
(3) The extremely large tabulare, exposed dorsally as in *Heloderma*.
(4) The great length of the slender squamosal which extends forward nearly to the jugal.
(5) The corresponding reduction of the postorbital.
(6) The embossed tuberculate osteoderms slightly suggesting *Heloderma* in ornamentation.
(7) Quadrate peculiar in having a broad, thin, semicircular internal wing.
(8) Lower jaw massive, curved posteriorly as in *Heloderma*.
(9) Meckelian sulcus completely covered.
(10) Splenial extensive posteriorly.
(11) Angular with extensive external surface covering the surangular as a thin plate somewhat as in *Gerrhonotus*.
(12) Paroccipital a separate element as figured by Leydig for *Lacerta agilis*.

Taken up in the order enumerated, these characters will be briefly discussed for the purpose of showing more clearly the reasons for not accepting Camp's conclusions.

(1) It is true that in *Melanosaurus maximus* (*Xestops* of Camp) the palatal teeth are extensive, but in some species of *Glyptosaurus*, and especially in *Peltosaurus granulosus*, the patches of palatal teeth are hardly more numerous than in the anguid lizards *Gerrhonotus* and *Ophisaurus*. (2) The massiveness of the jugal is not especially out of proportion to the much larger size of the extinct forms, and in shape it is certainly very similar to extant Anguidae. (3) The tabulare has now been clearly recognized in the type of *Glyptosaurus montanus* (see fig. 71) and its relative size and the extent of its dorsal exposure is found to be typically anguinoid (4 and 5). The squamosal is relatively long and the postorbital correspondingly reduced, but neither is considered of family significance. (6) The osteodermal covering of the head in *Glyptosaurus* is distinctive, but if a family character, how can the squamation of the head scutes of *Peltosaurus* and *Xestops*, which have a regular pattern resembling certain Anguidae be harmonized to their inclusion within the Glyptosaurudae? (7) The quadrate displays important distinctive characters, but Camp's observations were based on a single specimen of *Melanosaurus* (*Xestops*), and it is not known whether these same features are present in the quadrates of other genera which he proposes to include in the Glyptosauridae; in *Peltosaurus* the internal wing is narrow. (8) The massiveness of the lower jaw is a difference of degree, and I am not at all certain that it is out of proportion to the larger size of the extinct forms as contrasted with the much smaller living members of the family. An equal curvature of the posterior portion of the ramus is also to be observed in *Gerrhonotus*. (9) The Meckelian sulcus is equally well covered in the living members of the Anguidae. (10) The splenial is also extensive posteriorly in that family. (11) The resemblance of the angular to *Gerrhonotus* is recognized by Camp. (12) A distinct paroccipital bone is present in *Melanosaurus* (*Xestops*), and so far as I can learn it has not been recognized as a separate element in other Anguidae. Is this, however, a character of family importance? I do not think so.

The above review, it seems to me, quite clearly shows that at present there exists no good reason for the reestablishment of the family Glyptosauridae. Very few of the characters enumerated by Camp are considered to be of family significance; a few are of relatively minor importance; and, considered singly or collectively, I would not regard any of the distinctions as more than generic. In view of the many similarities in the skull structure of both *Glyptosaurus* and *Peltosaurus* when compared with *Gerrhonotus* and the limbless *Ophisaurus*, such few differences are found as to raise but little doubt as to their affinities being with the Anguidae, and it seems to me desirable to retain these extinct forms in that family until a more perfect knowledge of their skeletal anatomy discloses characters which will justify their removal to a distinct family.

Eight species were described by Marsh under the genus *Glyptosaurus*, *G. sylvestris*, *G. ocellatus*, *G. rugosus*, *G. princeps*, *G. brevidens*, *G. nodosus*, *G. sphenodon*, and *G. anceps*. None was figured and all very briefly described. After a comparative study of the type specimens in connection with all available materials, I now regard *G. brevidens* and *G. ocellatus* as being synonymous with *G. sylvestris*. *G. anceps* is clearly not a glyptosaurid reptile but belongs to the Amphisbaenidae. (See p. 47.) *G. sphenodon* Marsh and *G. obtusidens* Loomis are retained although inadequately distinguished as to species. *Helodermoides tuberculatus* Douglass becomes *G. tuberculatus*. Six other species, *G. rugosus*, *G. princeps*, and *G. nodosus* Marsh, *G. montanus* Douglass, *G. giganteus*, new species, and *G. hillsi*, new species, are recognized, so that at present the genus contains 10 species. Their geological distribution is shown in the accompanying table.

Geologic distribution of the species of Glyptosaurus

Period		Formation		Species
Oligocene	Upper	White River	Oreodon zone	*G. giganteus.*
	Middle		Titanotherium zone	*G. montanus*, *G. tuberculatus*, *Glyptosaurus* sp. (Cypress Hills).
	Lower			
Eocene	Upper	Uinta		*Glyptosaurus* sp.
	Middle	Bridger	C	*G. sphenodon.*
			B	*G. nodosus*, *G. princeps*, *G. rugosus*, *G. sylvestris.*
			A	
		Huerfano	Upper	*Glyptosaurus* sp., *G. hillsi.*
			Lower	*Glyptosaurus* cf. *hillsi.*
		Wind River		*Glyptosaurus* sp.
	Lower	Wasatch	Upper	*G. obtusidens.*
			Lower	

The fragmentary nature of the material upon which the species of *Glyptosaurus* have been founded makes the work with this genus very difficult. Fortunately, in a few instances, the discovery of topotypes has made it possible to more adequately diagnose certain species. The key given below has been worked out largely on the basis of the frontal bone with its scutal ornamentation, as this element was present in the greatest number of the type specimens and thus furnished a common basis of comparison. It will be observed that many of the species are distinguished on very slender evidence. In justification of this, especially when differences in the cranial scutes form the basis of distinction, it would seem probable that these features of osseous ornamentation are quite as much to be relied upon as the external scutellation of modern lizards upon which the herpetologist depends so largely in the classification of existing members of the Sauria.

SYNOPSIS OF THE OSTEOLOGICAL CHARACTERS OF GLYPTOSAURUS

Skull.—Parietal undivided, expanded laterally, roofing over supratemporal fossa, with pineal foramen; frontals usually separate; inferior plates of frontal straight or infolded, never fully inclosing olfactory lobes, nasals distinct; prefrontals elongate, extending above orbit but never meeting the postfrontal; postfrontal subtriangular; postorbital apparently present but excluded from orbital border; jugal large, massive, rectangular; articulating principally with postfrontal; occipital distinctly tripartite; supratemporal fossa roofed over by dermal scuta; tabulare present; columelli cranii present; supratemporal arch present; pterygoid wide with large patch or one or two narrow bands of teeth.

Jaws.—Meckel's groove closed except at anterior end; surangular extending forward, even with or beyond anterior suture of coronoid; splenial wide posteriorly, narrowly contracted anteriorly, strongly visible from a lateral view; surangular, articular, and prearticular coossified to form one bone; angular short, showing broadly in lateral view; angle strong, directed downward and inward; coronoid high.

Teeth.—Pleurodont; transversely compressed crowns, with beveled outer faces, sharp; posterior teeth blunt with low longitudinal ridge; crown surfaces smooth or striated.

Vertebrae.—Cervicals shortened, keeled; anterior dorsals with low but sharp median keel, rapidly subsiding into dorsals with convex ventral surfaces; precondylar constriction slight; condylar end set off by annular groove; diapophyses vertical, narrow; sacral vertebrae not coossified; caudal vertebrae with short transverse processes; chevrons pediculate, and placed posterior to the middle; neural spines of caudals moderate. No zygosphenial articulation.

Arch and limb bones.—Ilium with short, forward projecting process. Humerus with ectepicondylar foramen.

Dermal scuta.—Highly embossed tuberculated osteoderms on head and body. Those on head more or less of equal size usually without definite arrangement, those of body rectangular and united laterally by suture, some with low carina.

Key to species

OLIGOCENE

(Oreodon beds)

Typically largest size; frontals broad, massive, coossified; scuta large, strongly convex, irregularly arranged; pits, with few tubercles, irregularly arranged. Teeth unknown	*G. giganteus*

(Titanotherium beds)

Typically of small size; frontals thin; scuta very small, fairly regular in size, strongly convex, ornamented with pointed tubercles, irregularly arranged. Teeth crowns smooth, compressed cutting edge obtusely pointed	*G. montanus.*

(Pipestone Creek beds)

Typically large, frontals narrow, moderately heavy, distinct; scuta strongly convex, median scutes broader than long, all ornamented with rounded tubercles, irregularly arranged. Teeth crowns smooth, slightly compressed, cutting edge acutely pointed	*G. tuberculatus.*

EOCENE

(Bridger beds)

Typically of medium size; frontals moderate thickness, distinct; scuta flattened, median ones broader than long, with nodelike centers, ornamented with rounded tubercles irregularly arranged. Tooth crowns delicately striated, compressed, with cutting edges rounded from front to back. Pterygoid teeth in a narrow band, sometimes two narrow parallel bands	*G. sylvestris.*
Typically of medium size, frontals thickened, distinct; scuta flattened, ornamented with tubercles arranged in rows radiating from center. Pterygoid teeth forming a large patch	*G. princeps.*
Typically of medium size; frontals coossified, moderate thickness; scuta small, moderately convex, ornamented with tubercles irregularly arranged. Tooth crown striated, with distinct but low cutting edge	*G. rugosus.*
Typically small; frontals distinct, moderate thickness; scuta nodelike, usually longer than wide, ornamented with tubercles placed in longitudinal rows. Teeth unknown	*G. nodosus.*
Typically very small, frontals unknown; scuta unknown. Tooth crowns smooth, compressed, very sharp	*G. sphenodon.*

(Huerfano beds)

Typically of large size, frontals partially distinct, moderate thickness; scuta flattened tubercles arranged in more or less concentric rows. Teeth heavy, with striated obtuse crowns with a low longitudinal ridge. Pterygoid teeth forming a moderate-sized patch	*G. hillsi.*

(Wasatch beds)

Typically of small size. Frontals unknown. Tooth crowns faintly striated, compressed cutting edge obtusely pointed	*G. obtusidens*

GLYPTOSAURUS SYLVESTRIS Marsh

(Pl. 4, fig. 4; pls. 12, 13, 14, figs. 6 to 9)

Glyptosaurus sylvestris Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 1, 1871, p. 456: Proc. Acad. Nat. Sci. Philadelphia, 1871, p. 105.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Douglass, Earl, Ann. Carnegie Mus., vol. 4, 1908, pp. 281, 282.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 40.—Gilmore, C. W., Mem. Carnegie Mus., vol. 7, 1917, p. 160.

Glyptosaurus ocellatus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 1, 1871, p. 458: Proc. Acad. Nat. Sci. Philadelphia, 1871, p. 105; Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 306.—Leidy, J., Rep. U. S. Geol. Surv. Terr., vol. 1, 1873, p. 183, pl. 16, figs. 13–17.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Douglass, Earl, Ann. Carnegie Mus., vol. 4, 1908, p. 282.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 40.—Gilmore, C. W., Mem. Carnegie Mus., vol. 7, No. 2, 1917, p. 160.

Glyptosaurus brevidens Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 305.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Douglass, Earl, Ann. Carnegie Mus., vol. 4, 1908, p. 282.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 40.—Gilmore, C. W., Mem. Carnegie Mus., vol. 7, 1917, p. 160.

Type specimen.—Yale University Museum, catalogue No. 526. Consists of the left frontal. Collected by C. T. Ballard, 1870.

Type locality.—Grizzly Buttes, Uinta County, Wyo.

Horizon.—Horizon B, Bridger formation, Middle Eocene.

Original description.—The present species may therefore be characterized as having, on the frontals between the orbits, shields of moderate thickness, but little elevated, with those in the middle row in each frontal broader than long. Each shield is covered with numerous small polished tubercles, crowded together with no definite arrangement. Ventral shields with ornamentation were found with some remains of this species and probably belong with them.

Measurements

	Lines
Width of single frontal at posterior margin	7. 80
Width of single frontal between orbits	5. 30
Length of 5 posterior shields on middle row of frontal	9. 00
Length of fragment of jaw bearing 3 teeth	4. 10
Length of ventral shield, probably of this species	8. 40
Width of same	4. 75

The present specimens indicate a reptile about 4 feet in length.

Although a "ventral shield" and a "fragment of a jaw bearing three teeth" are mentioned in the original description, their definite association with the described frontal appears very uncertain. These parts can no longer be recognized in the Yale collection of lacertilian materials, so that the genus and species now rest upon the nearly complete left frontal shown in Plate 12, Figures 7 and 7a. This agrees with Marsh's description and measurements, and furthermore, the cork of the vial in which it is preserved is plainly marked, evidently by Marsh, "(Type) *G. sylvestris*." A glance at the illustrations is sufficient to show the meager character of the specimen. It is quite sufficient for generic reference, and with the aid of topotypes is regarded as specifically determinable. The following details serve to supplement Marsh's brief description.

The type frontal shows that it joined its fellow of the opposite side by a distinct median suture. On the posterior end is a straight transverse suture for union with the parietal. On the external border are plainly indicated sutural depressions for the articulation of the pre-and postfrontal bones. These do not meet above the orbit as in *Heloderma*, but are separated by a space of 7.4 millimeters where the frontal contributes to the supraorbital border. The pointed anterior end of the frontal is missing. The dorsal surface, as Marsh observed, is covered with shields of "moderate thickness." The peripheral portion of most of the shields is flat or but slightly raised, with a decided nodelike elevation at their center. Their surfaces are covered with numerous small polished tubercles without definite arrangement, though there is a tendency, especially of the peripheral tubercles, to form in circular rows around the raised central portion. The shields are five and six sided and so closely joined to one another as to entirely cover the underlying bone. Many of the lateral shields are detached and missing, thus showing the frontal surface to be smooth except for slight grooving. On the ventral side there are well-developed longitudinal ridges that partially enclose the olfactory lobe of the brain. On its external side this ridge is strongly beveled, forming the supraorbital border. The olfactory ridges did not meet on the median line to enclose the olfactory lobes as in *Heloderma*, but were widely separate as in *Peltosaurus* and other Anguidae. The frontal, as preserved, has a greatest length of 31 millimeters; a greatest width at the posterior end of 15.8 millimeters; width at the center of the of the orbit, 12 millimeters. The length of five posterior shields on the middle row of the frontal is 20 millimeters.

In 1872, Marsh described the species *Glyptosaurus brevidens* as follows:[10]

> The present species is well represented by the greater portion of a skeleton in remarkable preservation. The reptile appears to have been covered up, soon after death, in the soft mud of the lake, and thus the bones, and even many of the dermal scutes, were preserved in their natural position. The remains indicate a species about as large as *Glyptosaurus ocellatus* Marsh, and probably a nearly related species. The frontals are proportionately thicker than in *G. sylvestris* Marsh, but are covered with similar scutes. The malar arch was massive. The teeth are rodlike, close together, and unusually short, projecting but slightly beyond the jaw. The summits are obtuse and marked by irregular striae. The pterygoid teeth are minute and arranged in a narrow band. The dermal scutes on the malar region are very thick and have their tubercles in concentric rows, forming an ocellated pattern. The dorsal plates are large, quadrilateral in form, with the lateral margins united by suture, and the ends imbricate. The exposed parts of these scutes are covered with small tubercles arranged near the margin in rows. The center is more or less carinate longitudinally. The cervical vertebrae have a keel below, which gradually subsides in the dorsal region. The articular ball is surrounded by a deep groove.

Measurements

	Mm.
Width of frontals between orbits	19. 0
Space occupied by 5 posterior upper teeth	7. 5
Width of occipital condyle	8. 0
Depth of lower jaw at cotylus	12. 0
Length of centrum of anterior dorsal vertebra	11. 0
Width of articular cup	6. 8
Expanse of anterior zygapophyses	15. 0
Length of dorsal scute	13. 5
Width of same	8. 0

It will be noted that the chief distinction pointed out between this species and *G. sylvestris* is that "the frontals are proportionately thicker than in *G. sylvestris* Marsh." I have compared the frontal bones of the specimens upon which these two species are based and find them to be almost identical. The slightly greater thickness of the frontal of *G. brevidens* on the median border may be accounted for by the retention of the cranial scutes in places along this edge, whereas in the type of *G. sylvestris* these lateral scutes are missing. The close agreement in size of the frontals, together with the similarity in shape, arrangement and character of the ornamentation of the attached dermal scute leads me to the conclusion that the two specimens belong to the same species, and I therefore regard *G. brevidens* as a synonym of *G. sylvestris*.

When discovered the type of *G. brevidens* (No. 521, Yale Museum, see pls. 13 and 14, figs. 6 to 9) was probably preserved with the bones and dermal scutes more or less in their natural relationships. Either in collecting or subsequent handling the specimen has been badly broken a condition which has very largely defied all efforts at reconstruction, so that much of its orignal worth has now been dissipated. The bones, except for breakage, are in a fine state of preservation, but judging from the recognizable parts preserved there was never more than the anterior half of the skeleton present. Its greatest value lies in the definite association of identifiable skull parts with several short vertebral series from the cervical and dorsal regions thus furnishing the first information as to the character of the vertebral column in *Glyptosaurus*. Some of the largest and most characteristic portions of this specimen are shown in Plate 13, Figures 1 to 8, and Plate 14, Figures 6 to 9.

In addition to the frontal bones which have already received some attention, I am able to identify the detached basioccipital bone, median portions of both jugals, posterior portion of the left maxillary, left postfrontal, a small portion of one pterygoid, and considerable parts of both lower mandibles. The trilobate form of the occipital condyle, although no sutures can be detected, apparently indicates that the exoccipitals participate about equally with the basioccipital in the formation of the reniform condyle. It has a greatest width of 8 millimeters; a greatest depth at the center of 4 millimeters. The ventral surface of the basioccipital is broadly concave transversely, as in *Heloderma*. The jugal, as Marsh has observed, is "massive." At the center of the orbit it has a greatest vertical diameter of about 6 millimeters and a transverse thickness of 4.5 millimeters. The left jugal fragment is suturally joined to the posterior end of the maxilla of that side which bears four posterior teeth, as shown in Plate 13, Figure 8. The external surfaces of the jugals are covered with pentagonal shields arranged in two curved, longitudinal rows, the curve corresponding to the concavity of the lower border of the orbit. Four scutes of the lower row extend a distance of 10.5 millimeters.

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[10] Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 305.

The left postfrontal is firmly attached by suture to the posterior portion of the frontal of that side, and inferiorly with a portion of a bone, which I regard as the extremity of the jugal. (See pl. 13, fig. 3.) From this rather fragmentary evidence it would appear that in the genus *Glyptosaurus* there is either a fusion of the postorbital and postfrontal bones to form a single element as in *Heloderma*, or else the postorbital has been pushed backward and no longer participates in the border of the orbit. In the postfrontal of specimen No. 1072, Yale Museum, a sutural pit (see pl. 12, fig. 4 *po*) in the posterior border indicates an attachment for either the postorbital or the squamosal, but it seems highly improbable that the squamosal would reach such an anterior position, and in all probability this pit is for the attachment of the postorbital. In the Gerrhosauridae the postorbital is also excluded from the orbit.[11] By some authorities it is considered that only the postfrontal is retained in *Heloderma*, but Camp observes that in *Heloderma horridum* "there seems to be a trace of a suture between the postfrontal and postorbital."[12]

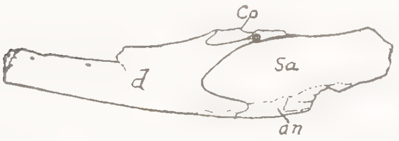

FIG. 61.—Left dentary of *Glyptosaurus sylvestris* Marsh. (Type of *G. brevidens* Marsh, No. 521, Yale Mus.) Three-fourths natural size. Outer view. *an*, angular; *co*, coronoid; *d*, dentary; *Sa*, surangular

After a thorough review of the subject as to the presence or absence of one or the other of these bones, Camp concludes that "it seems that total reduction and true absence of the postfrontals occurs only among the iguanids, agamids, and chamaeleons; fusion has occurred almost indiscriminately in various other groups."

A small section of one of the pterygoid bones shows a patch of minute teeth arranged in a narrow band, as shown in Plate 12, Figure 3.

Lower jaws.—The lower mandible is represented by considerable portions of both rami. (See fig. 61.) From a study of both elements it has been possible to determine many of the principal features of the jaw for fortunately most of the sutures are clearly defined. Both rami lack the anterior portions of the dentaries and much of the alveolar borders. On the external side the dentary is overlapped by a broad, pointed prolongation of the surangular. Above and below this anterior end of the surangular the dentary is produced backward as two slender, tapering, sharply pointed processes, the superior one being interposed between surangular and coronoid, the inferior between surangular and angular. Meckel's groove, as exposed, faces downward and inward, and so far as preserved in this specimen was entirely closed by the overlying splenial. The splenial terminates posteriorly at a point below the center of the coronoid, with which it is in contact. Widest at the posterior end, it contracts rapidly to a slender, narrow anterior extension that entirely covers the groove. It is very slightly exposed from a lateral view. The angular is broadly exposed laterally, with an anterior extension equal to that of the surangular. Its posterior extent can not be determined from these rami, but it is quite apparent that it did not reach the angle of the jaw. The surangular and articular are fused as in several genera of the Iguanidae. These two elements, with the prearticular, if that bone is present, form the posterior half of the ramus. Beginning posterior to the coronoid, the upper border turns inward with a long sweeping curve, but posterior to the widely expanded cotylar portion it swings downward, forming the angle which is missing in these specimens. The basal portion of the coronoid is all that remains of that bone. It sets astride the anterior upper border of the surangular and sends forward two processes that lap the posterior end of the dentary, the internal extension exceeding the external in length.

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[11] Camp, C. L., Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p. 361.

[12] Op. cit. p. 360.

Dermal scutes.—Numerous small patches of articulated dermal scutes of both head and body are preserved. Some of the largest and most characteristic of these are illustrated in Plate 13, Figures 1 to 9.

The rectangular body scutes were arranged in transverse rows with their lateral margins united by suture and their ends imbricated, the extent of the imbrication being indicated by a smooth transverse band across their anterior ends. This smooth band constitutes about one-third of their total length. The exposed surfaces are thickly studded with rounded polished tubercles, those near the margins being arranged in two and sometimes three concentric parallel rows. The outer row of tubercles are the largest, the others becoming successively smaller. The centers of the scutes are usually obscurely carinate longitudinally, though the carina is absent in a few. These probably belong to the ventral side of the body and lack the regular arrangement of the tubercles in rows of the carinate shields. The ornamentation is well shown in Plate 13, Figures 4a, 5, 6, and 7.

The scutes of the frontal and jugal regions have already been described in connection with those bones. In addition to those osteoderms mention should be made of the group of dermal elements shown in Plate 13, Figure 6. The position of these scutes in relation to the skull is unknown, though it is suggested that they may have covered the side of the head posterior to the orbit. The especial point of interest in connection with them is that they so closely resemble the type specimen of *Glyptosaurus ocellatus* Marsh (No. 526, Yale Museum, see pl. 13, figs. 4 and 4a) as to leave no doubt of their specific identity. This specimen will be described in detail later.

Vertebrae.—Eighteen presacral vertebrae, of which at least two may be regarded as belonging to the cervical series, are preserved with specimen No. 521, Yale Museum. Many of these are in short articulated series of from two to four vertebrae each, as shown in Plate 14, Figures 6 to 9. The two cervical vertebrae present are so broken and abraded as to furnish but little information as to their principal features. It is shown that they have a keel but its full extent cannot be determined. The cervicals, as in *Heloderma* and also in some members of the Anguidae, are proportionally shorter and less massive in their construction than in the dorsal series. The centra of the dorsal vertebrae are moderately depressed and with the articular face of the ball turning upward and backward. Except in the anterior dorsal region, where a low, sharp, keel-like ridge persists on the median line (see pl. 14, fig. 7), the ventral surface is convex in transverse section. On either side, behind the inferior extremity of the parapophyses, is a faint, shallow longitudinal groove that sets off the middle region of the centrum as a wide band, not so pronounced but resembling somewhat the dorsal vertebrae of *Peltosaurus.* The articular ball is marked off by a curved, transverse groove, as shown in Plate 14, Figure 9. Viewed ventrally, the vertebrae of *Glyptosaurus* may be distinguished from those of *Saniwa,* whose remains occur in the same beds, by the almost total absence of the necklike constriction of the centra near the condylar end. External to the faint longitudinal groove mentioned above an obtuse diagonal ridge running slightly upward and backward to the lower third of the transverse process marks the separation between ventral and lateral aspects. Above this ridge, occupying the side of the centrum, is a concavity, widest posteriorly and rapidly narrowing toward the front. This is bounded above by the deeply incised but prominent ridge which connects the zygapophyses. The transverse process is vertical and narrow anteroposteriorly; its articular face is not subdivided. A dorsal vertebra partially inclosed in matrix and articulated with three others, and probably from the mid-dorsal region, is the only one present in this specimen having the neural spine preserved. It rises well above the neural arch. (See pl. 14, fig. 6.) It is thin transversely, wide fore and aft, with a slightly thickened upper extermity. The anterior border is inclined, but the posterior rises more vertically. Over all, this vertebra has a greatest height of 17.5 millimeters.

Viewed from above, the arch between the zygapophyses is deeply incised (see pl. 14, fig. 8), with its surface steeply inclined downward toward the anterior end. I find no trace of zygosphene or zygantrum. The zygapophyses are expanded and placed wide apart, though in a dorsal of specimen No. 1073, Yale Museum, there is a slight outfolding, forming an open groove at the bottom of the anterior zygapophysis.

In his original description of *Glyptosaurus brevidens* (see p. 97) Marsh has given the principal measurements of a dorsal vertebra, and these dimensions may be taken as an average of any of the thoracic vertebrae preserved, with this specimen so slight is the deviation.

The type of *Glyptosaurus ocellatus* Marsh (No. 523, Yale Museum) consists of the small group of dermal plates shown in Plate 13, Figures 4 and 4a, from the same locality and geological horizon as the type of *G. sylvestris*. As stated on page 99, these are so similar as to leave no doubt of the specific identity of the two specimens. The original description also fully delineates the principal features of the homologous scutes of *G. brevidens*. Marsh described *G. ocellatus* as follows:

> The present species, which was perhaps the largest of the lizards collected by our party, is readily distinguished from the two preceding [*G. sylvestris* and *G. nodosus*] by the pattern of ornamentation on the cranial plates, which are very thick, united by suture, and have the tubercles arranged in concentric series. The outer row of tubercles is considerably the largest, and the next two or three successively smaller; while the center is occupied by a group of very small tubercles, with no definite arrangement. The effect of this is to produce an ocellated appearance in each shield, which has suggested the specific name. This effect is increased in one very perfect specimen by the central group of tubercles being of a lighter color.

A year later the discovery of a second specimen (No. 1072, Yale Museum) enabled him to add the following:[13]

> Among our Eocene fossils are several specimens which evidently belong to *Glyptosaurus ocellatus*, and fortunately afford additional specific characters. One of these specimens has the frontal bones perfect, one postfrontal, and a number of other important parts of the same skull and skeleton. The frontals are slightly sigmoid longitudinally, the posterior margin and the interorbital region being elevated. They are closely covered with thick osseous scutes, which have their tubercles so arranged as to form an ocellated pattern. The plates of the middle row on each frontal between the orbits have their length and width nearly equal. The pterygoid bones have a narrow band of teeth near their inner margin, and exterior to this in front a second short band. This species was rather larger than the type specimen of *G. sylvestris*.

Measurements

	Mm.
Length of frontals on median line	38. 0
Width between orbits	19. 5
Width at posterior margin	32. 4
Transverse diameter of distal end of humerus	18. 4

This last specimen is important in having present bones that had not before been known in *Glyptosaurus*—the humerus, ilium, distal end of a femur, and the proximal portion of a tibia, all of which are illustrated in Plate 12, Figures 1 to 6.

The left postfrontal unites with the frontal by a cupped articular border that extends under the outer posterior angle of the bone and is only slightly in contact with the parietal much as in *Heloderma*. Ventrally the border is cut by a V-shaped longitudinal groove for the reception of the upper extremity of the jugal. On the extreme posterior border a deep, cone-shaped pit (see pl. 12, fig. 4 *po*) extending forward into the bone apparently represents the presence of a postorbital bone which, if present, is entirely excluded from participation in the orbital border. A similar condition is found in *Araeoscelis*. (See fig. 4.)

The pterygoid bone, showing a narrow band of teeth, is in accord with the fragment preserved with the type of *G. brevidens*, a feature which also assists in distinguishing *G. sylvestris* from *G. princeps* with its large patch of pterygoid teeth, as may be seen by comparing Plate 12, Figure 3, and Plate 15, Figure 8.

The portion of the humerus shown in Plate 12, Figure 6, except for its larger size, is indistinguishable from the homologous bone of *G. rugosus*, more fully described on page 104. The right ilium, lacking its distal extremity, is shown in Plate 12, Figure 2, and is distinguished at once from *Heloderma* by the presence of a short, pointed process extending forward from the upper border as in *Varanus*, whereas in *Heloderma* this border is smoothly rounded. The other features are clearly shown in the illustration. The greatest anterior-posterior extent of the acetabular portion measures 11.5 millimeters; the greatest vertical depth of the bone at this end, 10 millimeters. The distal end of the femur has a greatest transverse width of 14 millimeters. The tibia, which lacks some of its distal articular end, is shown in Plate 12, Figure 5. A short, thickened phalanx has a greatest length of 7.8 millimeters, with a median ridge on the proximal end and a groove on the distal.

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[13] Amer. Journ. Sci., vol. 4, 1872, p. 306.

Specimen No. 6054, American Museum of Natural History, is provisionally identified as pertaining to the present species because of the ocellated sculpturing of the dermal scutes. If this identification is correct, we have in this specimen the first knowledge of the parietal bone in this species. It is a thin, square plate of bone. (See pl. 4, figs. 3 and 4.) The frontal parietal suture is straight transversely with a slightly thickened rugose sutural surface. Laterally and posteriorly the borders thin out to sharp edges. The divergent posterior processes are missing. The posterior border at the center is indented by a V-shaped notch as in *G. hillsi*. (See pl. 4, fig. 4.) The dorsal scutes are missing except for a patch forward of the center of the bone which consists of a group of small median osteoderms around which are arranged in radiating fashion a series of larger plates. In the style of their ornamentation they closely resemble those of the frontal region of the type and referred specimens previously described.

On the posterior ventral surface are three prominent ridges. The two lateral and divergent ones extend backward to give support to the slender processes that extend backward to meet the tabulare; the median one, which is high at the center, rapidly subsides as the posterior border is approached. Its ventral border is grooved. Anteriorly the walls of the groove suddenly diverge to form deep lateral ridges that contribute to the formation of the posterior walls of the brain case. A deep pit marks this change, and a pineal foramen perforates the bone at the bottom of this depression. The parietal has a greatest length at the center of 27 millimeters and a greatest width of 28 millimeters. The fragment of maxillary contains six teeth from the middle of the maxillary series. Their crowns extend somewhat below the alveolar border and are transversely compressed, with sharp cutting edges, as contrasted with the blunt rounded crowns of the posterior maxillary teeth. Four teeth occupy a space of 8 millimeters. The crowns are prominently striated, the striae running at nearly right angles to the cutting edge on both sides.

REFERRED SPECIMENS

In addition to the type the following specimens referable to *Glyptosaurus sylvestris* were used in this study of the skeletal anatomy of this species:

No. 523, Yale Museum, type of *G. ocellatus* Marsh. Consists of a small patch of cranial scutes. Horizon B_2, Bridger formation, Middle Eocene, Grizzly Buttes, near Fort Bridger, Uinta County, Wyo. Collected by H. B. Sargent, 1870.

No. 521, Yale Museum, type of *G. brevidens* Marsh. Many parts of a broken skull and jaws, several short articulated series of cervical and dorsal vertebrae and numerous patches of skull and body osteoderms. Locality and horizon same as the preceding. Collected by Prof. O. C. Marsh in 1872.

No. 1072, Yale Museum. (Referred by Marsh to *G. ocellatus*, Amer. Journ. Sci., vol. 4, 1872, p. 306.) Consists of the complete frontals, left postfrontal, fragment of left jugal, median portion of left pterygoid bearing teeth, distal half of left humerus, right ilium, distal articular end of left femur, proximal half of left tibia, distal phalanx, and a few dermal scutes from body and head. Horizon and locality same as the preceding. Collected by J. F. Page, September 1, 1871.

No. 1073, Yale Museum. Nearly complete right frontal and skull fragments; several dorsal vertebrae, numerous fragments of the same; greater part of radius, distal ends of both humeri, and numerous dermal scutes. Horizon and locality same as the preceding. Collected by G. G. Lobdell, September 5, 1871.

No. 6054, American Museum of Natural History. Consists of the nearly complete parietal, a portion of the left jugal, alveolar border of one maxillary bearing six teeth and numerous quadrangular osteoderms. Horizon and locality same as the preceding. Collected by Walter Granger, 1903.

GLYPTOSAURUS PRINCEPS Marsh

(Pl. 15, figs. 1, 3, 4, 7, 7a, 8)

Glyptosaurus princeps Marsh, O. C., Amer. Journ. Sci., 3d. ser., vol. 4, 1872, p. 302.—King, C., U. S. Geol. Expl. 40th Par., vol. 1, 1878, p. 405.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Douglass, Earl, Ann. Carnegie Mus., vol. 4, 1908, p. 282.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 40.—Gilmore, C. W., Mem. Carnegie Mus., vol. 7, no. 2, 1917, p. 160.

Type specimen.—Yale University Museum, catalogue No. 524. Consists of a considerable portion of the coalesced frontals, median part of right pterygoid, fragmentary portions of both rami including symphysial end of left dentary, numerous dermal scutes, one phalangeal bone, and many fragments. Collected by O. C. Marsh, September 1, 1871.

Type locality.—Near Grizzly Buttes, Uinta County, Wyo.

Horizon.—Horizon B, Bridger formation, Middle Eocene.

Original description.—The present species exceeds in size any of the genus hitherto discovered. It is represented at present by the more important parts of a skull, with some portions of a skeleton and numerous scutes of one individual, and by a few other fragmentary remains. The lower jaws have their rami curved in front, like those of *Heloderma*. The lower teeth are close together, and had their bases deeply fluted. The frontal bones are very massive, and the longitudinal groove on their lower surface is proportionally narrow. The pterygoid teeth are numerous and are closely and irregularly crowded together. They are tubercular and collectively resemble the pattern of some of the dermal plates. The cranial scutes preserved have the tubercles more irregular in size and arrangement than in the other species of the genus. The remains indicate a reptile fully six feet in length.

Measurements

	Mm.
Space occupied by anterior 12 lower teeth	23. 0
Width of frontals at posterior edge of nasal suture	15. 6
Width at posterior edge of prefrontal suture	19. 0
Greatest thickness of frontals on median line	5. 0
Width of cotylus of lower jaw	12. 0
Longitudinal diameter	8. 0

The type specimen is in a very fragmentary condition, but its large size, massive frontals coossified on the median line, with lateral olfactory ridges strongly incurved, and with dorsal osteoderms relatively flat and ornamented with tubercles that are usually arranged in rows radiating from the center of each scute, constitute a combination of characters which appear sufficient to distinguish *Glyptosaurus princeps* from the other species of the genus.

The principal features of the frontal bones, here illustrated for the first time, are well shown in Plate 15, Figures 7 and 7a. The tubercles on the frontal scutes, which are usually arranged in radiating rows from the center, have a tendency to merge into one another to form ridges, instead of being distinctly defined as in *G. sylvestris* and other allied species. This condition is also true of the tubercles on the few body plates preserved with the type specimen.

The median portion of the right pterygoid has on its lower surface a large patch of small tubercular teeth (see pl. 15, fig. 8). They are closely and irregularly crowded together, and, as Marsh has pointed out, "collectively resemble the pattern of some of the dermal body plates." On the upper surface a deep pit marks the seat of the lower end of the epipterygoid bone. This fragment has a greatest length over all of 25 millimeters. The other skull fragments show no features of importance.

The lower jaw is represented by the articular portions of both rami, a median portion of the articulated surangular, angular, splenial, coronoid, and dentary and the anterior portion showing the symphysial end of the left dentary. The articular, prearticular, and surangular are so thoroughly coalesced as to leave no trace of their union. So far as preserved they appear as a single bone; the angle portion is missing in both. The cotylus is shallowly bifossate. Immediately in front of the cotylus the ramus has a greatest vertical diameter of 28 millimeters. Both upper and lower borders at this point present rather sharp edges. The median portion, except for its larger size, appears indistinguishable from the same part of the mandible in *G. sylvestris*, as represented in the topotype. Where the splenial and dentary are broken away on the ventral border in the present specimen, it discloses the anterior end of the angular as being a long, pointed process that extends well forward inside the dentary and splenial, which in a perfect specimen would be entirely hidden from view.

On the lower internal side is a large internal mandibular foramen whose boundaries are contributed to by the surangular, angular, and presumably the splenial. It opens backward and inward. This specimen also shows that the coronoid was but little produced posteriorly. The anterior portion of the dentary near its anterior end curves in broadly to meet its fellow of the opposite side; they are joined by a weak median suture. The dentary is vertically grooved for the reception of pleurodont teeth of which only the basal portions of a few remain; the most anterior ones are strongly inclined forward. In cross section they have an oval pulp cavity with its greatest diameter transverse to the jaw. The walls of the teeth are thick. The teeth were placed close together, a few showing fluting at their bases. The external surface of the dentary is perforated by the usual row of foramina.

A single complete phalanx is preserved with this specimen, but as to whether it belongs to a fore or hind foot I am unable to determine. The bone is somewhat depressed, with expanded ends. The proximal end is cupped; the distal is shallowly grooved at the center. The bone is 7 millimeters long.

In the collection of lacertilian remains from the American Museum of Natural History is a fragmentary specimen (No. 5113) which I have identified as belonging to the present species. It is from the same locality and horizon as the type of the species and is important in having portions of the skull and skeleton present which are not represented in the type. It is practically the same size as the type.

Almost the entire frontal region with a portion of the articulated left prefrontal are shown in Plate 15, Figure 5. It shows the frontal region to have been flat both longitudinally and transversely, but turning downward rapidly from the fronto-prefrontal suture. The presence of a lachrymal bone is indicated by a groove on the lower border of the prefrontal. Many of the osteoderms are detached, but those remaining are but little convex and have the same radiating arrangement of the tubercles found in the type. The pre- and postfrontal bones are separate above the orbit as in the other described species. Between the orbits the frontals have a greatest width of 21 millimeters; at their posterior end, 32 millimeters; at anterior end between prefrontal borders, 15 millimeters. The right maxillary, lacking some of its anterior extremity, bears a series of 12 well preserved posterior teeth (see pl. 15, fig. 3), which occupy a space of 22 millimeters. They are closely set, with long shafts that are slightly flattened anteroposteriorly. The apices of the teeth are not expanded but are compressed transversely with a long bevel of the crown to the external maxillary face. On the opposite side the shorter bevel, which is slightly concave, gives the apices an especial robustness when viewed from the top. The crowns thus have a cutting edge in the long axis of the jaw. Under the binocular both their internal and external surfaces are delicately parallel wrinkled at right angles to the cutting edge. Except for the greater uniformity of the wrinkling, I fail to note any difference which would serve to distinguish these teeth from those of *G. sylvestris*.

Dermal body scutes with this specimen show an arrangement of the outer tubercles in parallel rows as in *G. sylvestris*, but which also have a tendency to form radiating rows as in the head scutes.

A second specimen in the collection of the American Museum (No. 1614) is tentatively referred to the present species on account of the massiveness and coossification of the frontal bones and the strong infolding of the olfactory ridges. The dorsal scutes, however, do not have the typical radiating arrangement of the tubercles, and it is on that account that I have some hesitancy in making this reference. Associated is the distal third of a left humerus. The condyles are missing, the bone is much compressed, with a prominent flattened process given off on the radial side much as in *Saniwa ensidens*. (See fig. 52.) The sudden expansion and development of this process at once distinguishes the humerus of *Glyptosaurus* from that of *Heloderma*. In cross section the broken end of the shaft is elliptical with the greatest diameter in the plane of the expanded distal end. Greatest diameter of the shaft is 5.7 millimeters; least diameter, 4.3 millimeters.

REFERRED SPECIMENS

In addition to the type, the following specimens were studied in connection with this species.

No. 5113, American Museum of Natural History. Consists of the nearly complete articulated frontals with portion of left prefrontal; parts of both maxillaries; fragment of palatine with teeth; fragments of dentary; and numerous dermal scutes. Horizon B, Bridger formation, Middle Eocene, Grizzly Buttes, Uinta County, Wyo. Collected by Albert Thompson, June 15, 1903.

No. 1614, American Museum of Natural History. Consists of the median part of the frontals and other fragmentary portions of the skull; distal portion of humerus; proximal end of tibia; and numerous dermal scutes. Bridger formation, Middle Eocene, Buck Springs, Alkali Creek, Uinta County, Wyo. Collected by Walter Granger, August 12, 1909.

GLYPTOSAURUS RUGOSUS Marsh

(Pl. 16)

Glyptosaurus rugosus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 305.—Boulenger, G. A., Proc. Zool. Soc., London, January 20, 1891, p. 116.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Douglass, Earl, Ann. Carnegie Mus., vol. 4, 1908, p. 282.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 40.—Gilmore, C. W., Mem. Carnegie Mus., vol. 7, no. 2, 1917, p. 160.

Type specimen.—Yale University Museum, catalogue No. 525. Consists of the posterior portions of the coossified frontal bones. Collected by T. G. Peck, September 4, 1872.

Type locality.—Grizzly Buttes, Uinta County, Wyo.

Horizon.—Horizon B, Bridger formation, Middle Eocene.

Original description.—This species may be readily distinguished from *Glyptosaurus sylvestris*, and other allied forms, by the osseous scutes on the frontals, which are smaller than in any known species of the genus. These plates are prominently convex, and have their tubercles nearly all of equal size, and without definite arrangement. The prefrontal and postfrontal bones, moreover, approach each other, above the orbit, much nearer than in the species hitherto described. The remains preserved of this species indicate an animal about 3 or 4 feet in length.

Measurements

	Mm.
Width of both frontals at posterior margin	31. 0
Width between orbits	22. 0
Extent of postfrontal suture on frontal	13. 5
Distance between prefrontal and postfrontal	3. 2
Thickness of frontal on median line between orbits	3. 4

There is little to add to the brief description of the type given above, except that the frontal bones are so fully coossified as to entirely obliterate all trace of their sutural contact on the median line. (See pl. 16, figs. 7 and 7a.) It should also be mentioned that the most anterior scute preserved near the broken edge of the left frontal shows an ocellated arrangement of the tubercles as in *G. sylvestris.*

In so far as the type specimen is concerned, *Glyptosaurus rugosus* appears to be distinguished by the smaller and more equal size of the osseous scutes of the posterior frontal region, their great convexity, and their lack of definite arrangement. In all of these respects it resembles *G. montanus* Douglass, but its very much greater size would at once distinguish it from that species.

A specimen in the collection of the American Museum of Natural History (No. 6055) is referred to this species. The frontals, which are complete and coossified (see pl. 16, fig. 1), have their dorsal surfaces covered with small, convex scutes which, as in the type specimen, are of nearly equal size, with the posterior ones, at least, without regular arrangement. Anteriorly, however, they form longitudinal rows. The ornamentation of these scutes differs from that noted in the type specimen in that the tubercles on many of them are arranged in concentric rows. The contribution of the frontal to the orbital border is also greater in this specimen. Between the pre- and postfrontal processes the frontal contribution to the orbital border measures 7 millimeters, whereas in the type this measurement is only 3.2 millimeters, though the specimens are of about equal size.

Measurements of frontals of No. 6055, American Museum of Natural History

	Mm.
Length of frontals on median line	34. 8
Width between orbits	20. 0
Width at posterior margin	28. 0
Extent of postfrontal suture on frontal	10. 5

If correctly identified this specimen gives us the first information as to the character of the parietal and its scutellation in *G. rugosus*. It is quadrangular in outline and, so far as they can be compared, appears indistinguishable from that of specimen No. 6054, American Museum of Natural History, referred to *G. sylvestris*. On the median line approaching the frontoparietal suture is a well-defined pineal foramen which perforates the posterior half of a very large median osseous scute. A small fragment of a pterygoid bone shows the patch of pterygoid teeth arranged in a narrow band much as in *G. sylvestris*.

On the dorsal surface the scutes on the central areas are small, five and six sided and without regular arrangement. Outside of these the plates become larger with the ornamenting tubercles arranged in quite regular concentric rows. The principal features of the parietal bone are well shown in Plate 16, Figure 1. That a tabulare bone is present is clearly shown by a lateral groove on the ventral divergent process of the parietal. The dermal plates present have the usual rectangular shape with the same ornamentation as found in *G. sylvestris*. Some of them are carinate. Differences in width of the smooth articular band at the anterior end are shown in Plate 16, Figures 3 and 4.

The first information as to the character of the humerus in this species is learned from the perfectly preserved proximal and distal ends of a left humerus (see pl. 16, figs. 2 and 5); the connecting piece of shaft is missing. The articular head is suboval in outline transversely and evenly rounded fore and aft, and slightly overhangs the shaft posteriorly. The deltoid ridge is prominently developed. On the flexor surface the distal end is partially divided by a groove into two convex condyles, the external one being much more prominently developed than the inner. A narrow but deep trochlia fossa lies just above these condylar processes. On the external side the bone is pierced by a small ectepicondylar foramen that passes diagonally upward through the lateral margin of the bone. The entocondylar expansion at the distal end of the humerus is much more angular in outline than in *G. sylvestris*. (Compare pl. 12, fig. 5 and pl. 16, fig. 6.)

Measurements of humerus

	Mm.
Greatest transverse diameter of proximal end	16. 0
Greatest anteroposterior diameter of head	6. 8
Greatest diameter of distal end	16. 0
Greatest anterior posterior diameter	8. 3

Except for the differences noted above in the larger size of the frontal osteoderms and in the humerus, this specimen might equally well be referred to *Glyptosaurus sylvestris*. It may eventually be shown that the species *G. rugosus* is the same as *G. sylvestris*, though for the present it seems best to keep them distinct.

Glyptosaurus nodosus Marsh

(Pl. 14, figs. 2, 3, 4, 4a, 5)

Glyptosaurus nodosus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 1, 1871, p. 458; Proc. Acad. Nat. Sci. Philadelphia, 1871, p. 105.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Douglass, Earl, Ann. Carnegie Mus., vol. 4, 1908, p. 282.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 40.—Gilmore, C. W. Mem. Carnegie Mus., vol. 7, no. 2, 1917, p. 160.

Type specimen.—Yale University Museum, catalogue No. 522. Consists of frontal, two body scutes, and an unidentified skull fragment. Collected by O. C. Marsh, 1870.

Type locality.—Grizzly Buttes, Uinta County, Wyo.

Horizon.—Horizon B, Bridger formation, Middle Eocene.

Original description.—In this species, which was somewhat smaller than the one above described [*G. sylvestris*], the frontals are thicker at the median suture, and the shields between the orbits very convex. The middle row of each frontal in this region has the shields longer than wide, and subhexagonal. The tubercles on the shields are also proportionally larger, and less crowded together. The plates of the body have the same ornamentation as the cranial shields, and some of them are keeled. The species was about 3 feet in length.

Measurements

	Lines
Width of single frontal, between orbits	4. 50
Length of 4 shields on middle row of frontal	8. 60
Length of ventral shield	7. 10
Width	3. 40
Length of dorsal vertebra from edge of cup to end of ball	5. 60
Width of cup	3. 75
Depth of cup	1. 95
Expansion of posterior zygapophyses	5. 60

This is probably a valid species though very inadequately known at the present time. The very decided convexity of the shields on the frontal bone appears to distinguish it from all described species except *G. tuberculatus* (Douglass), from which it differs in its very much smaller size and in having the shields arranged in regular longitudinal rows. Marsh's statement that the frontals are thicker at the median suture than in *Glyptosaurus sylvestris* I do not regard as of importance, since a direct comparison of the two bones shows such a slight degree of difference as to be negligible. As in the other species the frontals were sutured on the median line and the pre- and postfrontals did not meet above the orbit, a space of 7 millimeters of frontal border separating them.

Marsh presents various measurements of a dorsal vertebra but no other mention is made of this element. If this belonged to the type specimen it has been lost or misplaced, and I am unable to recognize it in the Yale collection of lacertilian remains.

The two rectangular scutes show no distinctive features. In size and in the ocellated arrangement of the ornamentation they are indistinguishable from scutes of *G. sylvestris*. All of the bones comprising the type and only known specimen are fully illustrated in Plate 14, Figures 2 to 5. The frontal bone as preserved has a greatest length of 25.5 millimeters.

GLYPTOSAURUS SPHENODON Marsh

(Pl. 18, figs. 12, 13)

Glyptosaurus sphenodon Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 306.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Douglass, Earl, Ann. Carnegie Mus., vol. 4, 1908, p. 283.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 40.—Gilmore, C. W., Mem. Carnegie Mus., vol. 7, no. 2, 1917, p. 160.

Type specimen.—Yale University Museum, catalogue number 1051. Consists of a small portion of a right maxillary bearing two complete teeth. Collected by T. G. Peck, September 23, 1871.

Type locality.—Near Henry's Fork, Uinta County, Wyoming.

Horizon.—Horizon C or higher, Bridger formation, Middle Eocene.

Original description.—A smaller species, probably belonging to the genus *Glyptosaurus*, is indicated in our collections by some fragmentary remains, among which the most characteristic specimen is a portion of an upper jaw with several teeth. These are peculiar and differ essentially from any yet discovered in the Green River basin. The crowns are long, cylindrical, separated slightly from each other, and directed obliquely backward. The summits are compressed, and very sharp. The bases of the teeth are rugose, and the crowns smooth. The species was about 2 or 3 feet in length.

Measurements

	Mm.
Space occupied by 4 upper teeth	6. 0
Height of upper tooth on inner side	4. 5
Extent beyond jaw	2. 0
Anteroposterior diameter of crown	1. 2

The specimen on which Marsh established this species is of such a fragmentary nature as to render the validity of its assignment very doubtful. He was probably correct in regarding it as belonging to the genus *Glyptosaurus*, but I am far from being positively certain of that. The rugose bases, compressed crowns, and anteroposteriorly flattened shafts would appear to indicate glyptosauroid affinities, and the smooth, sharp-edged crowns would serve to distinguish the species from those previously described. While it might appear best to abandon this species on the ground of inadequateness of type material, I propose to retain it, especially since it comes from horizon C or higher of the Bridger formation, a horizon in which no other glyptosaurian has been discovered. The principal features of the type specimen are shown in Plate 18, Figures 12 and 13.

Glyptosaurus hillsi, new species

(Pl. 4, fig. 3; pl. 17.)

Glyptosaurus, Hills, R. C., Proc. Colorado Sci. Soc., vol. 3, 1888–1890, p. 221.—Osborn, H. F., Bull. Amer. Mus. Nat. Hist., vol. 9, 1897, p. 249; Bull. U. S. Geol. Surv., No. 361, 1909, p. 49.

Type specimen.—United States National Museum, catalogue No. 6004. Consists of the greater portion of the top of the skull; both maxillae containing teeth; both quadrates; anterior portions of both jugals; greater portion of right ramus and portions of left; two dorsal vertebrae; dermal scutes. Collected by R. C. Hills, 1889.

Paratype.—United States National Museum, catalogue No. 10606. Consists of the parietal, skull fragments, and numerous quadrangular dermal scutes. Collected by R. C. Hills, 1889.

Type locality.—Muddy Fork of Huerfano River, above Gardiner, Huerfano County, Colo.

Horizon.—"Variegated beds about 35 to 40 feet below ash beds," Upper Huerfano formation, Eocene.

The specimens selected as the type and paratype of this new species were included in the Marsh collection transferred to the United States National Museum by the United States Geological Survey in 1889. They are evidently the specimens that Professor Marsh identified as *Glyptosaurus* and to which reference was made by Mr. R. C. Hills in his paper *Additional notes on the Huerfano beds.*[14]

Historically these specimens are of interest as being the first of the genus to be reported from the Eocene deposits of the Huerfano Basin of Colorado.

The parts of the skull and jaws present are in a fine state of preservation, but unfortunately portions are missing which prevents the joining together of certain elements, as the maxillaries, jugal, and quadrates. The top of the skull is quite perfect except for the missing anterior ends of the nasals and the absence of the premaxillary. (See pl. 17, fig. 2.)

The type of *Glyptosaurus hillsi* exceeds in size any known specimen of the genus except *G. giganteus* from the Oligocene, which feature, combined with the longitudinally compressed posterior teeth with blunt, flattened crowns, serves at once to distinguish the species.

The specific name is in honor of the late Mr. R. C. Hills, who collected the specimens.

THE SKULL

The upper articulated portion of the skull, consisting of the parietal, frontals, nasals, and portions of the pre-and postfrontals is in a fine state of preservation, but the contacts for the maxillaries are missing. The parietal region is flattened, but becomes concave at the center posterior to and between the orbits as in *Heloderma.* Beginning in front of the orbits the upper surface of the skull slopes rapidly downward laterally to the maxillary region and more gradually toward the muzzle which is largely missing. The whole upper surface of the skull is completely covered with osseous scutes so closely joined that they entirely obscure the underlying sutural contacts of the bones forming this part of the cranium. Fortunately these sutures are clearly shown on the ventral side and the limitations of the elements, so far as they are present, can be accurately determined. (See fig. 63.)

The parietofrontal suture is nearly straight. Viewed from above the parietal is a rectangular bone slightly wider than long, with posterior lateral divergent processes that meet the tabulare and squamosal by a long, lapping suture. These posterior processes lack their posterior terminations in both type and paratype. The presence of a tabulare is clearly indicated by a groove on the posterior lateral border of these underlying divergent ridges. (See fig. 63.) The paratype shows the parietal to have a notch on the median posterior border. (See pl. 4, fig. 3.) There is a small pineal foramen, as shown in Figure 62.

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[14] Proc. Colo. Sci. Soc., vol. 3, 1888–1890, p. 221.

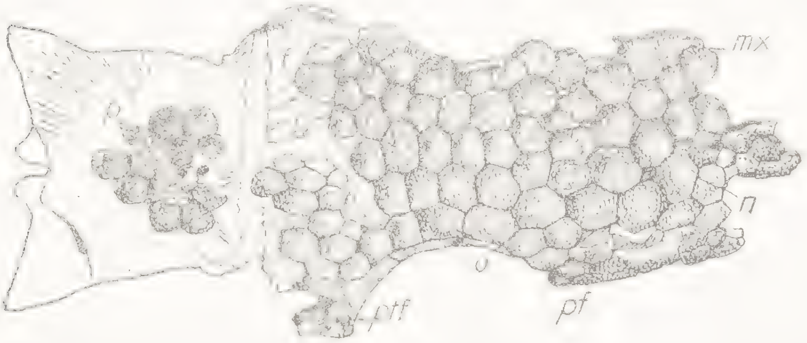

Fig. 62.—Skull of *Glyptosaurus hillsi* Gilmore. Type. (No. 6004, U. S. Nat. Mus.) About natural size. Viewed from above. *f*, frontal; *mx*, maxillary; *n*, nasal; *o*, orbit; *p*, parietal; *pf*, prefrontal; *ptf*, postfrontal

On the ventral side of the parietal there is a low, sharp median ridge that extends forward about half the length of the bone where it divides into two divergent but heavier branches that more anteriorly on the frontals merge into the stronger parallel ridges that form the lateral boundaries of the olfactory portion of the brain. These parallel ridges might be considered the anterior prolongation of the strong rounded ridges that support the divergent posterior processes of the parietal. (See fig. 63.) At the center the parietal is 29 millimeters wide and about 27 millimeters long. Frontals completely coalesced posteriorly, but distinct anteriorly. In several species of the genus the sutural contact of the paired frontals is plainly indicated. throughout their entire length. Posteriorly the frontals are relatively wide, measuring 39 millimeters from side to side where the postfrontals join them. Between the orbits, to which they contribute a portion of the median upper boundary, they contract to 27 millimeters in width. They are still further narrowed in front for union with the large prefrontals, the anterior ends being truncated. At the anterior end they measure 14 millimeters in transverse diameter. The nasals rapidly widen toward their forward termination. They are thick at the center but rapidly thin laterally and again increase in thickness and decrease in width toward the anterior termination.

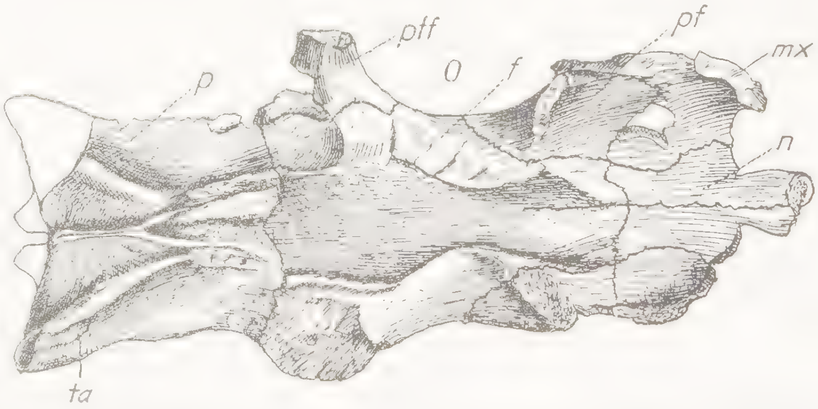

Fig. 63.—Skull of *Glyptosaurus hillsi* Gilmore. Type. (No. 6004, U. S. Nat. Mus.) About natural size. Viewed from below. *f*, frontal; *mx*, maxillary; *n*, nasal; *o*, orbit; *p*, parietal; *pf*, prefrontal; *ptf*, postfrontal; *ta*, depressed surface for tabulare

The pre- and postfrontals do not meet above the orbit as in *Heloderma*, but are separated by a short interval where the frontal contributes to the orbital boundary. A small portion of the proximal end of the right postfrontal is all that is known of that element in this species.

The prefrontals are large, subtriangular in form and apparently overlapping the maxillaries extensively at their anterior extremities.

The longitudinal ridges on the lower surface of the frontals that mark the olfactory region of the brain are relatively low and very slightly incurved. Their external sides are strongly beveled to the supraorbital border. This portion of the skull as preserved has a greatest length over all of 98 millimeters.

Only the median scutes of the parietal remain attached to this bone in the type, and these are small with conical centers that are ornamented with rounded tubercles rather irregularly arranged. The parietal of the paratype (see pl. 4, fig. 3) shows the scutes to enlarge from the center outward, their convexity becoming less, with a tendency for the tubercles to arrange themselves in concentric rows. On the frontal and nasal region the scutes are larger, of fairly regular size, and between the orbits form five longitudinal rows, which anteriorly and posteriorly break up into an irregular arrangement. They are moderately convex with the tubercles usually arranged in concentric rows. The posterior portions of both maxillae are present to which are attached the anterior extremities of both jugal bones. (See pl. 17, figs. 4, 4a.)

The orbital border of the jugal has a greatest transverse diameter of 7.4 millimeters. This maxillary shows the presence of eight posterior teeth; the left maxillary contains an equal number. Four of these teeth occupy a space of 12 millimeters. The external surfaces of these bones are covered with thin, flattened scutes of varying sizes and outlines, as shown in Plate 17, Figure 4. A little above the alveolar borders the scutes end abruptly leaving a border of the maxillary bases bare. The posterior teeth are especially strong and robust, with blunt crowns that at the apex are crossed longitudinally with the jaw by a low, blunt ridge, from which, and at right angles to it, are found striating grooves and ridges forming a roughened rugose area of oval shape on the top of the crown, which gives the surface a puckered appearance. A few deeper grooves extend downward on the internal side. Both of the quadrates lack much of their lateral borders so that their extent or shape can not be determined. The distal end is cut off at a bevel to its longer axis, and this end is broadly and shallowly grooved anteroposteriorly, the groove being nearer the inner border. The shaft is shallowly channeled longitudinally on the anterior face.

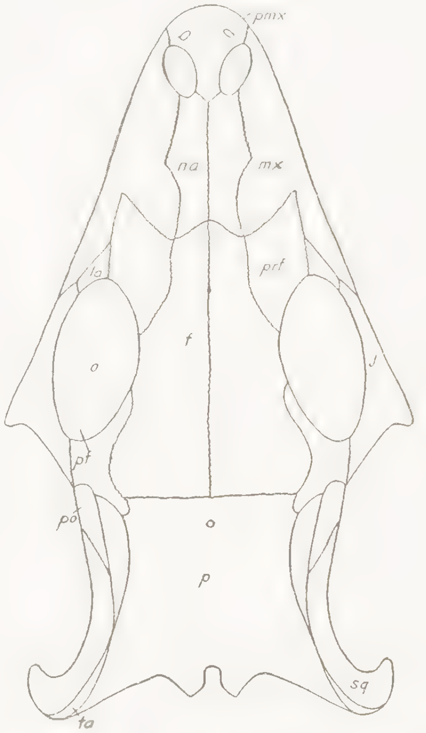

Fig. 64.—Skull of *Glyptosaurus hillsi* Gilmore. Tentative restoration of top of skull based on type and other species. Less than one-half natural size. *f*, frontal; *j*, jugal; *la*, lachrymal; *mx*, maxillary; *na*, nasal; *o*, orbit; *p*, parietal; *pmx*, premaxillary; *pf*, postfrontal; *po*, postorbital; *prf*, prefrontal; *sq*, squamosal; *ta*, tabulare

In Figure 64 is shown a tentative restoration of the top of the skull of *Glyptosaurus*, based primarily on the type of *G. hillsi*. The relative connection and extent of the median elements, if the nose is excepted, may be considered as accurately determined since they are based on a single well preserved individual. There is some question as to the accuracy of certain details in the articulation of the lateral elements, which are here restored on the evidence of several individuals. Reference is made especially to the articulation of postorbital, postfrontal, and jugal, the details of which are discussed elsewhere in this paper. Attention is directed to the fact that the postfrontal articulates internally principally with the frontals, whereas in *Peltosaurus* (compare figs. 64 and 75) its lateral articulation is about evenly divided between the parietal and frontal.

Measurements

	Mm.
Greatest length of quadrate	27. 5
Greatest width distal end, transversely	14. 0
Greatest width proximal end, anteroposteriorly	11. 7

A fragment of a pterygoid belonging to the paratype shows that pterygoid teeth were present. These are arranged in a large, irregularly shaped patch that has a greatest anteroposterior extent of 9.3 millimeters and a transverse measurement of 6 millimeters. Its area is relatively smaller than that of the pterygoid in *Glyptosaurus princeps*.

LOWER JAW

The right ramus of the type is beautifully preserved except for the loss of a small portion of the symphysial end (see pl. 17, figs. 1, 1a.), and this loss is more than supplied by the presence of the anterior symphysial portion of the left ramus. Of the latter there is also the articular portion present. Thus, from a study of these portions of the lower jaw, which supplement one another so perfectly, it has been possible to obtain, for the first time, a clear conception of the entire ramus and the relationships of the several elements entering into the structure of the lower mandible of *Glyptosaurus* as shown in Figure 65. On this account I describe this portion in considerable detail.

In the complete ramus the following elements are recognized: Dentary, angular, articular, surangular, prearticular, coronoid, and splenial. It is estimated that the complete ramus has a length of about 125 millimeters.

Dentary.—The dentary constitutes fully one-half of the entire ramus. Deepest at the posterior end, it narrows gradually toward the front, the anterior end turning rather abruptly to meet its fellow of the opposite side, as in *Iguana tuberculata*. Viewed from the side it is angularly convex from above downward, this convexity becoming more regularly rounded as the posterior extremity of the bone is approached. The upper external surface is perforated by the usual row of foramina. Posteriorly the dentary meets the surangular, angular, and coronoid bones, the principal articulation being with the surangular which extends into a wide, vertical, concave excavation of its posterior extremity, much as in *Gerrhonotus multicarinatus*. The most anterior part of this suture, however, is immediately below the forward external end of the coronoid, whereas in the living form mentioned it extends considerably forward of the anterior coronoid extension. In this respect the extinct anguid lizard *Peltosaurus* is intermediate between these two. The upper posterior margin of the dentary is deeply notched for the short external anterior extension of the coronoid.

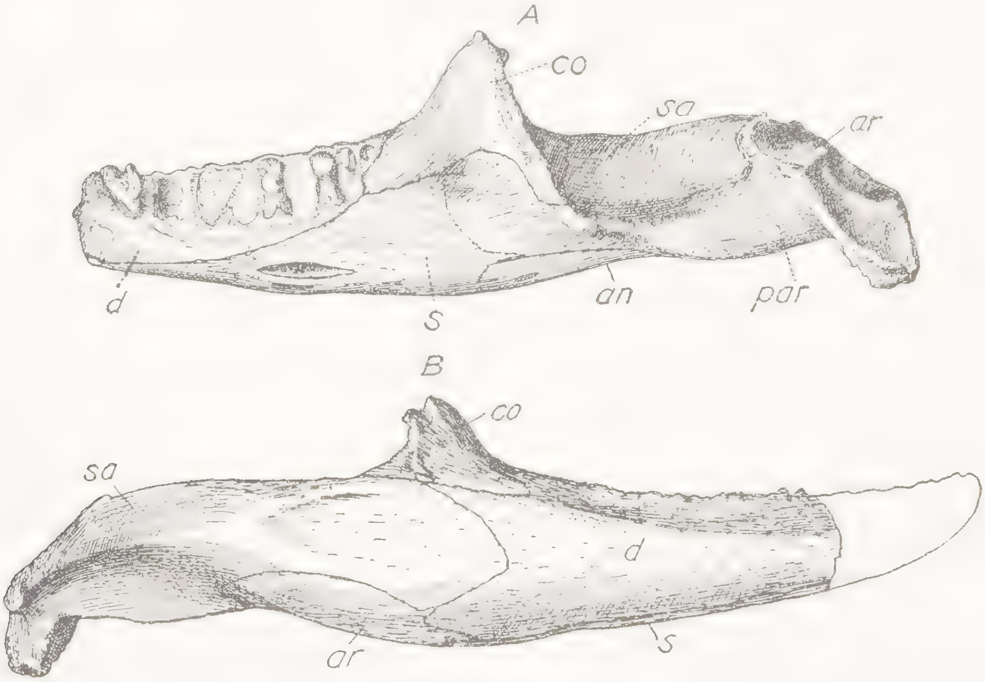

FIG. 65.—Right ramus of *Glyptosaurus hillsi* Gilmore. Type. (No. 6004, U. S. Nat. Mus.) Natural size. A, inner view; B, outer view. *an*, angular; *ar*, articular; *co*, coronoid; *d*, dentary; *par*, prearticular; *s*, splenial; *sa*, surangular.

Ventrally there is slight contact by an oblique suture with the angular. (See fig. 65A.) On the internal side the dentary bears a typical pleurodont dentition of somewhere between 18 and 22 teeth. The long, slender splenial completely covers Meckel's groove except for a very short span at the anterior end of the dentary. Where it is open on the under side, this bone laps along the inner side, extending very nearly to the symphysis. It also extends down under the dentary and is visible from a lateral view almost the entire length of the dentary. Posteriorly this splenial is extensive and unites with a nearly vertical suture beneath the center of the coronoid with the prearticular, and by a notch with the angular. (See fig. 65B.)

Angular.—The angular is a relatively small bone lying mostly external, though a small portion of its lower anterior end is visible from an internal view. It underlies the forward portion of the surangular and is in contact with the dentary and splenial at its anterior end.

Surangular + articular + prearticular.—The surangular, articular, and prearticular, as in all glyptosaurid lizards, are confluent, and the combined elements form the posterior half of the ramus. The surangular, as mentioned above, extends forward into a wide but deep vertical concavity on the posterior end of the dentary, its lower anterior half being underlapped by the angular which extends well up on the external side of the surangular. (See fig. 65B.) At a point about midway between the coronoid and the posterior end of the articular, the ramus bends inward toward the median line. The angle is incurved and deflected downward and slightly backward with concave superior surface, all features found in other Anguidae. The posterior end is cut off at an oblique angle to the long axis of the jaw and the inner border presents a thickened truncated end. The upper surface of the angle is deeply concave toward the inner side. The cotylus is shallowly concave from back to front, bifossate. It has a greatest width of 13 millimeters.

On the internal side in front of the cotylus, a forward extension of the articular, probably the prearticular, meets the splenial at a point below the center of the coronoid; this transversely thickened portion stands inward away from the main outer wall of the mandible. On top of this shelflike projection the surface is depressed at its anterior end where a large foramen leads into the interior of the ramus for the passage of Meckel's cartilage.

Splenial.—The splenial is a long, thin, tapering bone that is closely applied, principally to the inner side of the dentary. It completely covers Meckel's groove except for a short space at the symphysis. Posteriorly its widely expanded end meets the prearticular. Below it is in contact with the posterior end of the angular, and above by a longer contact with the overlying coronoid. That part of the splenial lying beneath the coronoid has a greatest vertical width of 16 millimeters but rapidly diminishes as it passes forward below the dental series. Its complete anterior extension can not be certainly determined although an examination of the anterior end of the left dentary, from which this portion of the splenial is missing, appears to show it to have extended very nearly to the symphysis.

Coronoid.—The coronoid is a compressed triangular element that extends high above the general level of the jaw, its upper extremity being bluntly pointed. Its upper portion has a slight inclination backward. Externally a short anterior extension is received in a notch on the upper posterior border of the dentary. Ventrally its contact with the dentary and surangular is about subequal, as shown in Figure 65. Internally a blunt anterior process extends well downward and forward and considerably exceeds the external extension in length. The internal surface of this bone is deeply concave from front to back. Posterior to this concave surface a heavy ridge, slightly inclined to the vertical, extends downward and backward to join the prearticular extension of the prearticular + articular complex.

Measurements of ramus

	Mm
Greatest length, about	125
Depth of ramus at posterior end of tooth row	21
Depth of ramus at anterior end of tooth row	9
Depth of ramus posterior to coronoid	19
Depth of ramus to top of coronoid	33
Transverse width middle of tooth series	10
Transverse width between coronoid and cotylus	10

TEETH

The pleurodont dentition of *Glyptosaurus hillsi* is represented as follows: Two complete posterior teeth in the right dentary; basal portions of three anterior dentary teeth of the left side; five complete teeth in the left maxillary; and three complete with basal portions of several others in the right maxillary.

The posterior teeth have blunt, stout crowns that are crossed longitudinally by a low ridge, on either side of which the surface is sculptured by delicate parallel grooves that usually run at right angles to the longitudinal ridge, as is clearly shown in Figure 66. The shafts of the teeth are everywhere compressed fore and aft. The inner bevel of the crown is much longer than the outer. It is estimated that the complete dentary series would consist of either 21 or 22 teeth.

An anterior tooth preserved in the right maxillary shows that the crowns of the anterior teeth become higher and more pointed, and the sculpturing, though still present, is less distinct and the longitudinal ridge evidently becomes the obtuse cutting edge of the crown. The inner face of the crown in this tooth is slightly concave, whereas the same face in the posterior teeth is decidedly convex.

In the posterior teeth the shafts are abruptly excavated below the crown, as shown in Figure 66 B, whereas in the anterior teeth the crown passes into the shaft without appreciable change.

The bases of the teeth rest on steeply inclined surfaces that are hollowed out into distinct grooves; those of the anterior teeth of the dentary are closely crowded together, and the first one or two are inclined forward. The teeth have a small pulp cavity, the walls of the crowns being relativley thick.

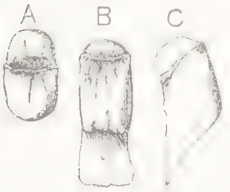

Fig. 66.—Posterior maxillary tooth of *Glyptosaurus hillsi* Gilmore. Type. (No. 6004, U. S. Nat. Mus.) Two and one-half times natural size. *A*, crown view; *B*, inner (buccal) view; *C*, anterior view

VERTEBRAE

Two dorsal vertebrae are preserved with the type specimen, and other than lacking the neural spines, are perfectly preserved. (See pl. 17, figs, 3, 3a.) They are relatively short bones with moderately depressed centra and elevated neural arches that have their dorsal surfaces strongly inclined toward the front. In cross section the centra are regularly convex. On either side of the broad convex center are shallow longitudinal depressions as in the topotype of *G. sylvestris*. The articular ball is set off by an annular groove and looks upward and backward. The diapophysis is strongly developed, vertical, and projects well outward from the centrum. The costal facet is rounded and its articular face looks almost directly outward. (See fig. 67.)

Zygapophyses wide apart and with elongated faces, steeply inclined. Border between anterior and posterior zygapophyses deeply incised by a rounded notch. No trace of a zygosphene. Arch above neural canal shallowly notched. Base of neural spine wide behind but contracting rapidly to a thin blade slightly anterior to the center. Sides of arch shallowly concave, a diagonal ridge marking transition from lateral to ventral surfaces.

Measurements of vertebrae

	No. 1	No. 2
	Mm.	*Mm.*
Greatest length of centra at center	13. 4	12. 7
Greatest width of cup	8. 6	8. 1
Greatest depth of cup	5. 5	5. 5
Greatest depth of vertebrae at center	13. 3	
Greatest transverse diameter of arch at center	12. 0	12. 5
Greatest transverse diameter of postzygopophses	17. 0	
Greatest transverse diameter across diapophyses	21. 3	21. 8

DERMAL SCUTES

Numerous dermal scutes belonging to the type specimen have the usual rectangular shape, with smooth articular surface one-third the total length, as in *G. sylvestris* and some other species. These scutes are large, some carinate, many with a conical elevation instead of a ridge. Tubercles low, usually arranged in regular rows paralleling the border. Toward the center of the scutes there is usually no regularity of arrangement.

REFERRED SPECIMENS

In addition to the type specimens the following are provisionally identified as belonging to *Glyptosaurus hillsi:*

No. 1617, American Museum of Natural History. Consists of dermal scutes and fragments of two vertebrae. Upper beds of Huerfano formation, 2 miles north of Gardner, Huerfano County, Colo. Collected by the American Museum expedition of 1918. The large size of the scutes and the close resemblance of their sculptured surfaces to those of the type apparently indicate their specific identity.

No. 1619, American Museum of Natural History. Consists of three unassociated jaws (anterior half of a left dentary, right maxillary, and fragment of a maxillary, all bearing teeth). Lower beds of the Huerfano formation, in the Garcia Canyon region, Colo. Collected by the American Museum expedition of 1918. Although all three jaws are slightly smaller than the type of *G. hillsi*, the characteristic blunt teeth of the posterior part of the dental series appears to justify their assignment to this species. The dentary portion is of interest as showing that the teeth change from the blunt, rounded crowns in the posterior part of the series to the compressed and sharper cutting edges in the front part of the dental row, the latter being very similar to those of other species of the genus. These specimens are also of interest as being the first members of the genus to be found in the lower beds of the Huerfano.

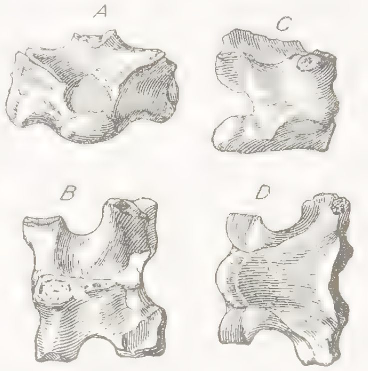

FIG. 67.—Dorsal vertebra of *Glyptosaurus hillsi* Gilmore. Type. (No. 6004, U. S. Nat. Mus.) Natural size. A, back; B, top; C, right outer; and D, ventral views

GLYPTOSAURUS TUBERCULATUS (Douglass)

(Pl. 18, figs. 1 to 11)

Helodermoides tuberculatus Douglass, Earl, Ann. Carnegie Mus., vol. 2, 1903, pp. 160, 161, text figs. 4, 5; Ann. Carnegie Mus., vol. 4, 1908, p. 280.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 40.

Type specimen.—Carnegie Museum, catalogue No. 707. Consists of the nearly complete frontal region of the skull articulated with posterior ends of nasals; a small, unidentified skull fragment to which are attached six osteoderms; and the greater part of the left dentary containing portions of several teeth. Collected by Earl Douglass, 1899.

Type locality.—Pipestone Creek, about 1 mile west of Pipestone Springs, Jefferson County, Mont.

Horizon.—Pipestone Creek beds, Titanotherium zone, Oligocene.

Original description.—The bone in the frontal region is thick and cellular, but is much thicker farther forward. The top of the skull, as in *Heloderma*, is covered with bony ossicles. They are higher and more conical than in that genus, and instead of being marked with minute pits are covered with little rounded wartlike protuberances. The larger ossicles approach a pentagonal or hexagonal form at the base. Two, near the middle of the head, are elongated transversely. Anterior to these there is no bilateral symmetry in their arrangement or size. The posterior ones, as in *Heloderma*, are smaller than the anterior ones.

The mandible shows three foramina on the outer surface. The teeth, which are partly set in the jaw, are sharp, laterally compressed near the apex, and incline slightly backward.

Length of fragment of skull, 40 millimeters.

Douglass described this specimen as the type of the new genus and species *Helodermoides tuberculatus*, the generic name evidently indicating his belief that its affinities were with the Helodermatidae, a family assignment later given it by Nopcsa. A direct comparison of the type with specimens of *Glyptosaurus* fails to disclose any generic differences, and I therefore refer the species to that genus which has priority by several years.

The resemblance to *Heloderma* in having the frontal region covered with bony scutes has been pointed out by Douglass, but its distinctness from that genus is indicated by the nonunion of the pre- and postfrontal bones above the orbit and by the fact that the olfactory lobes of the brain are not fully inclosed by the bony olfactory ridges of the frontals.

The frontal portion of the skull consists of the nearly perfect left frontal, anterior half of the right, and posterior extremities of the nasal bones, all articulated. Both frontals and nasals are joined by suture on the median line. (See pl. 18, fig. 10a.) Broken cross sections of the frontal and nasal bones show them to be strongly thickened and cellular. Sutural surfaces on the lateral borders of the frontal show that the postfrontal and prefrontal did not meet above the center of the orbit, but were separated for a distance of 5 millimeters. The greatest width of the combined frontals across the center of the orbits is 23 millimeters; across the nasals at their posterior ends, 13 millimeters. The greatest thickness of the frontals, which includes the olfactory ridges, is 12.5 millimeters. The nasal bones join the frontals by beveled sutural surfaces, the former extending backward upon the sloping ends of the underlying frontals.

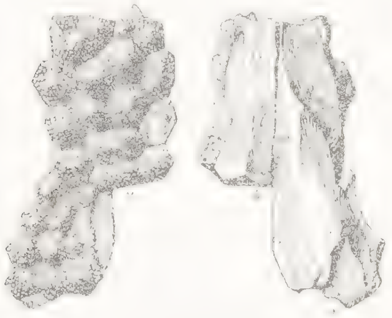
FIG. 68.—Frontals and posterior ends of nasals of *Glyptosaurus tuberculatus* (Douglass). Type. (No. 707, Carnegie Museum.) *a*, top view of skull; *b*, lower view of skull. Natural size. (After Douglass)

The principal features of the osteoderms of the frontal region have been sufficiently described by Douglass. (See fig. 68.) In the conical character of the head scutes *G. tuberculatus* most nearly approaches *G. nodosus* Marsh. It may, however, be distinguished from that species by its much larger size, the more pronounced character of its scutellation, the greater relative thickness of the frontal bones, and the nearer approach of the pre and postfrontals above the orbit. In the last respect the species approaches *G. rugosus* Marsh.

In addition to the frontal portion described above there is another small skull fragment covered with six osteoderms, but whose position in the cranium I am unable to determine.

The greater portion of the left dentary is shown in Plate 18, Figure 11. It contains the bases of a number of pleurodont teeth, but only two have their upper portions preserved and both of these have the tips of their crowns missing. They have expanded bases that are rectangular in outline when viewed from above. This basal portion is roughly grooved, the grooving, however, ending abruptly at a shallow encircling depression, and thus does not extend upon the shaft of the tooth, as in some of the other species.

A second specimen referable to the present species is No. 1611, American Museum of Natural History. It was collected at Pipestone Springs, Jefferson County, Mont., by the American Museum's expedition of 1902, and from the same geological level as the type specimen. It consists of the complete left frontal and the posterior half of the right; posterior portion of the right dentary containing a series of seven posterior teeth; three dermal scutes, one of which is keeled; one sacral vertebrae; and three anterior caudal vertebrae.

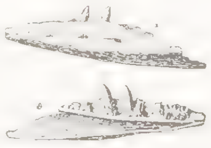
FIG. 69.—Left dentary of *Glyptosaurus tuberculatus* (Douglass). Type. (No. 707, Carnegie Museum.) Natural size. *a*, outer view; *b*, inner view. (After Douglass)

The frontal of this specimen is not quite so massive as the type and the osteoderms are slightly smaller, though they have the same conical shape and the character of their ornamentation is identical. At their posterior ends the combined frontals have a greatest transverse width of 28.5 millimeters; the complete frontal has a greatest length of 30.5 millimeters, whereas the type frontal measures 35 millimeters. The dentary carries a series of seven posterior pleurodont teeth, which increase gradually in size from the back toward the front; all are similar in form. The bases are slightly expanded and grooved, as in the type, and rest in a shallow depression on the inner inclined surface of the dentary, as shown in Plate 18, Figure 9. It is estimated from a comparison of the two known dentaries that the complete dental series of the dentary would consist of 15 or more teeth. The crowns are transversely compressed with bladelike cutting edges that are rounded off both fore and aft in the posterior teeth, but become more pointed toward the center of the series. Inner surface of the crown only faintly striated longitudinally. Below the crown the root is swollen and rounded on the inner side, but compressed fore and back. The crowns are inclined inward. Teeth are hollow, but with thick walls, as shown by the type. The dentary bone is thin as compared with the massive structure of the larger species of the genus, and Meckel's groove is greatly expanded toward the posterior end of the dentary.

The body scutes shown in Plate 18, Figures 1, 2, and 3, have the usual rectangular shape and are relatively thin. The single carinate plate preserved with this specimen has the tubercles arranged in more or less circular rows, one row within another. The other two scutes show no regular arrangement of the tubercles. The smooth articular end is much narrower in relation to the entire length of the scutes than previously observed. Whether this is a feature of all the body osteoderms or is confined to a particular area I am unable to determine. In the carinate plate this smooth area forms only one-fifth the total length of the plate.

A sacral vertebra (see pl. 18, fig. 7) preserved with this specimen is important as giving the first information of the sacrum in *Glyptosaurus*. It is well preserved except for the loss of the neural spine and the left diapophysis. The centrum is depressed, with two low, parallel, longitudinal ridges on the ventral surface, between which the surface is flat. Diapophysis flattened horizontal, broadly attached to the centrum. A pronounced groove on the posterior ventral surface runs outward from the side of the centrum. Articular face of ball looks upward and backward. Top of the arch inclined forward, deeply excavated between anterior zygapophyses. Articulation without zygosphene or rudiment of it. Sacrals not coossified.

Measurements

	Mm.
Length of centrum below	7. 5
Transverse diameter of articular cup	5. 3
Vertical diameter of articular cup	3. 7
Greatest width of sacral between ends of diapophyses	20. 0
Width across anterior zygapophyses	9. 1

The anterior caudal vertebrae have depressed centra, straight below with pedicles for chevron attachment prominent, and on the posterior third a shallow longitudinal groove on median ventral surface. Shallow annular groove around the ball. Transverse processes thin and having their origin on the side near the anterior end of the centrum, a thin, narrow, sharp, longitudinal ridge extending backward along the side. Neural spines are all missing, but their broken bases show them to have been comparatively narrow fore and aft. Anterior border between zygapophyses not excavated but forming a nearly straight transverse border with the zygapophyses. The principal features of these vertebrae are well shown in Plate 18, Figures 4, 5, and 6.

Measurements of caudal vertebrae

	No. 1	No. 2	No. 3
	Mm.	*Mm.*	*Mm.*
Greatest length of centrum below	11. 0	10. 0	8. 7
Greatest transverse diameter of ball	6. 0	4. 8	4. 0
Greatest vertical diameter of ball	3. 0	2. 5	2. 5
Greatest transverse diameter across anterior zygapophyses	10. 0	6. 5	6. 4

Glyptosaurus montanus Douglass

Glyptosaurus? montanus Douglass, Earl, Ann. Carnegie Mus., vol. 4, 1908, pp. 278–281, text figs. 1, 2.—Gilmore, C. W., Mem. Carnegie Mus., vol. 7, no.2, 1917, p. 160.

Type specimen.—Carnegie Museum, catalogue No. 1050. Consists of a nearly complete skull and lower jaws, humerus lacking distal extremity, distal extremities of radius and ulna, several separate shields, and parts of phalangal bones. Collected by Earl Douglass, July 13, 1903.

Type locality.—North of Big Hole River, at southeastern base of McCarty's Mountain, about 15 miles north of Dillon, Beaverhead County, Mont.

Horizon.—Titanotherium beds, Lower White River formation, Oligocene.

Original description—Distinguishing characters.—The skull is broad posteriorly and gradually narrows toward the muzzle. It is short in proportion to the width. The orbits are large and oval and with the long axis anteroposterior. Their vertical diameter is nearly the same as the distance between their upper borders. There is a superior temporal arcade. The mandible is moderately heavy. The teeth are smooth, have low, rounded, chisel-shaped crowns, and are pleurodont. Those on the maxillary are directed slightly backward.

The skull is nearly covered with tuberculated osseous shields which are arranged in a concentric manner around the orbits. These shields are not large but vary somewhat in size and form. They are convex on the upper surfaces and are covered with minute tubercles which are nearly equal in size.

Detailed description.—The parietofrontal plane of the skull is flat and very broad, twice as broad as the space between the orbits. Beginning above the anterior portion of the orbits the superior plane of the skull slopes downward to the anterior portion of the muzzle. The orbits are large and elliptical, the longer axis being in the direction of the long axis of the skull.

There is a superior temporal arcade and the jugal arch is heavy. The upper surface of the parietal was covered with shields. On removing these plates along the anterior border of the parietal and the matrix from the under surface of the bone it was seen that there was no contact with the frontal or any bone anterior to the parietals, except what appears to be a small thread of bone from the anteroexternal surface of the parietal to the frontal or postorbital. I am not able to say whether this is a normal condition or not, as there is no other skull with which to compare the type. The space between the bones, like the remainder of the roof of the skull, was covered with hard bony shields. The parietal sends out wings posterolaterally. These wings are sharp and thin anteriorly, but have ridges on their posteroinferior surfaces. Their upper surfaces are slightly convex, but are nearly in a horizontal plane. They do not face upward and forward as in *Iguana*. The parietal overlaps the squamosal with which it has a long surface of contact. The squamosal is long and sickle shaped. The shields prevent one from determining how far the bone extends anteriorly. There are no separate mastoid or prosquamosal bones. The quadrate is in place, but not all of it can be seen. It has a posterior longitudinal angle or ridge and the posterior upper portion of the bone projects backward. The frontals between the orbits are only moderately thick.

The mandible is quite thick transversely and is rounded on the inferior surface. The postdentary portion is nearly or quite as long as the dentary portion. It arches outward, the articulate portion being bent inward. The coronoid process is quite high. The teeth form an even row and are only a short distance apart. In the upper jaw the teeth which are visible increase slightly in height anteriorly. Apparently their anteroposterior diameters are slightly greater than their transverse diameters. They are low and their apices rounded.

The hard, osseous shields nearly cover the bones of the skull and the spaces between them. They vary in size, but none are as large proportionally as those of *Helodermoides tuberculatus* Douglass. Their upper surfaces are convex, and the forms of the peripheral boundaries vary with the amount of crowding of the contiguous shields. Some are nearly circular, some four, some five, and some six sided. They are arranged with a fair degree of regularity around the orbits. Each orbit had about 20 of these shields surrounding it in the fringing row or circle; the next row had at least 23 and probably 26. The third row was not continuous, but was interrupted beneath the orbit, and the two rows on the opposite sides unite the median line of the skull between the orbits, thus making five complete rows here. Posterior to the lower portion of the orbit the shields are larger. A central shield is surrounded by five large shields and one small shield. The three concentric rows around the orbits do not include an area on the median posterior-parietal portion of the skull, which is covered with about a dozen or more shields which are arranged in the form of a triangle, these short rows composing it extending in the same direction as the contiguous concentric rows. A little above the dental borders of the maxillaries the shields end abruptly, leaving a border of the maxillary bare. There were undoubtedly shields on the skin of the lower part of the head or throat. There are six still in the matrix beneath the postcoronoid portion of the mandible. There are also some larger, rather thin, shields, which probably belong to the lower part of the body.

The tubercles on the shields of the head are arranged in imperfectly concentric rows. There are from three to five or six of these rows on each scute. The tubercles are nearly equal in size. As before stated, the shields are convex on the upper surfaces.

Measurements

	Mm.
Length of skull, approximately	48. 0
Posterior width of skull	35. 0
Width of skull between the orbits	12. 0
Height of skull	16. 0
Height of skull, including mandible	23. 0
Anteroposterior diameter of orbit	19. 0
Vertical diameter of orbit	10. 0
Anteroposterior diameter of largest shields on skull	5. 0
Transverse diameter of largest shields on skull	3. 2
Length of body shields	7. 4
Estimated length of humerus	30. 0
Diameter of shaft of humerus	2. 7

These remains probably represent a lizard not less than 13 or 14 inches in length.

This specimen undoubtedly belongs to the family Anguidae, and apparently to the genus *Glyptosaurus* Marsh, though I have not had the opportunity of examining the various types of *Glyptosaurus* and they are not figured.

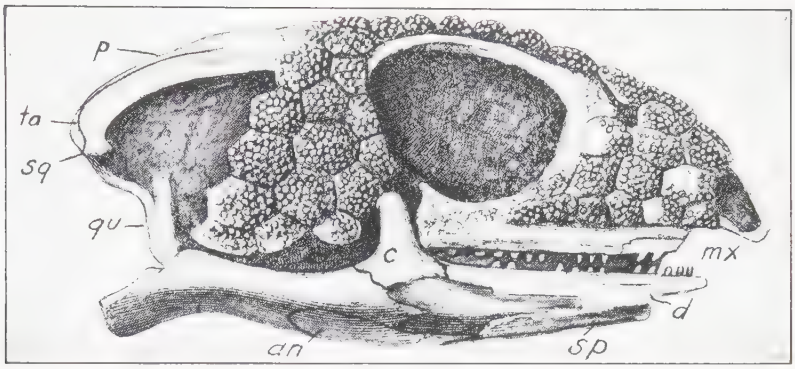

Fig. 70.—Skull of Glyptosaurus montanus Douglass. Type. (No. 1050, Carnegie Museum.) About twice natural size. Viewed from the right side. *an*, angular; *c*, coronoid; *d*, dentary; *mx*, maxillary; *p*, parietal; *qu*, quadrate; *sp*, splenial; *sq*, squamosal; *ta*, tabulare. (Modified from Douglass)

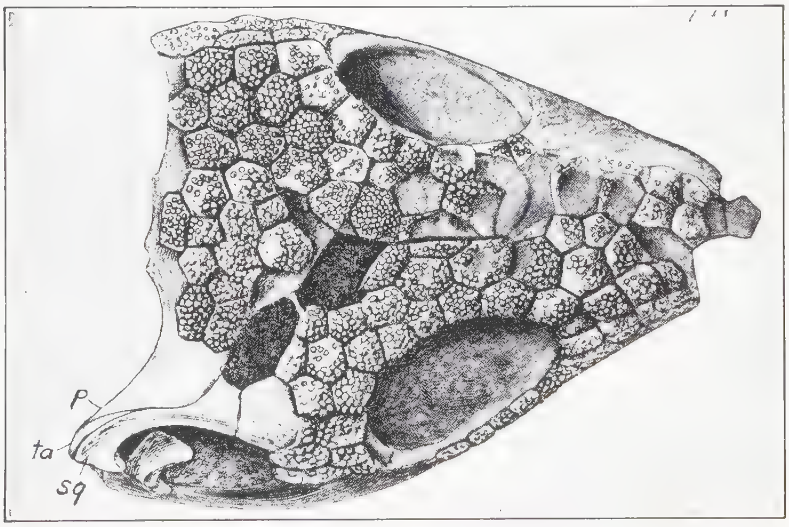

Fig. 71.—Skull of Glyptosaurus montanus Douglass. Type. (No. 1050, Carnegie Museum.) About twice natural size. Viewed from above. *p*, parietal; *sq*, squamosal; *ta*, tabulare. (Modified from Douglass)

The type specimen is the most perfectly preserved skull of the genus *Glyptosaurus* that has as yet been discovered. Its greatest interest lies in the fact that it gives for the first time an adequate conception of the shape of the skull as a whole, and a knowledge of the distribution and arrangement of the external covering of osseous scutes, although the bony structure is hidden from view by the attached osteoderms. Especially important is the evidence showing the presence of a suprătemporal arch and a distinct tabulare, clearly showing that those authorities who wish to refer *Glyptosaurus* to the Helodermatidae are in error. The recognition of the tabulare wedged in between the squamosal and posterior process of the parietal (see fig. 71) clears up an important structural feature of the glyptosauroid cranium that has long been in doubt.

The original description covers all of the salient features of the skull, but there are a few omissions which deserve mention. The post- and prefrontals do not meet above the orbit but are separated for a space of 3 millimeters by the interposition of the frontal, as in other species of the genus. The occiput of the skull is detached and missing. The right side of the palate appears to be intact, though the very refractory nature of the matrix in which it is embedded makes it practically impossible to develop these bones for observation of their structural details. The pterygoid is in contact with the quadrate posteriorly, but it can not be determined whether pterygoid teeth were present in this species or not. Evidently the pterygoids were widely separated on the median line. Palatine and vomerine bones are present, but their structural details are obscure. A columella cranii is present. The external nares open laterally. The anterior end of the premaxillary is missing. The lateral end of the parietal passes entirely over the anterior extension to the tabulare and is in contact with the squamosal, as in the allied *Peltosaurus*.

FIG. 72.—Outline of humerus of *Glyptosaurus montanus* Douglass. Type. (No. 1050, Carnegie Museum.) About natural size. Distal end missing.

A small block of concretionary matrix accompanying the type skull contains one humerus lacking the distal articular end and distal portions of the radius and ulna. Impressions in the rock make it quite evident that originally these bones were intact and articulated with the humerus. Douglass estimated the length of the complete humerus as 30 millimeters, which is probably close to correct. It is estimated that the ulna had a total length of 23 millimeters. This measurement is based on the impression and the distal portion still in the matrix. The nature of the humerus as preserved in the matrix is shown in Figure 72.

GLYPTOSAURUS OBTUSIDENS Loomis

(Pl. 19, figs. 1, 2)

Placosauridae Cope, E. D., Rep. U. S. Geogr. Surv. W. 100th Meridian, vol. 4, pt. 2, 1877, p. 42, pl. 32, figs 26, 36.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 474.—Merrill, G. P., Bull. U. S. Nat. Mus., No. 53, pt. 2, 1907, p. 75.

Placosaurus sp. Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 44.

Glyptosaurus obtusidens Loomis, F. B., Amer. Journ. Sci., 4th ser., vol. 23, 1907, pp. 358, 364, fig. 3.

Type specimen.—Amherst College, catalogue No. 133. Consists of median portion of the left dentary containing five teeth. Collected by F. B. Loomis, 1904.

Paratype.—Amherst College, catalogue No. 106. Consists of a ventral shield. Collected by F. B. Loomis, 1904.

Type locality.—Tatman Mountain, Big Horn County, Wyo.

Horizon.—Wasatch formation (higher level Tatman Mountain), Lower Eocene.

Original description.—The species from the Bridger are, with one exception, much larger. In the present form the cylindrical teeth are attached in a pleurodont manner, with about one-third of the tooth above the outer margin of the jaw. The crown of each tooth is slightly compressed, making a blunt edge front and back. Near the base is a small opening for the blood vessels into the pulp cavity, and on each alternate tooth this is enlarged by the absorption which has taken place near the successional new tooth. The five teeth occupy 6½ millimeters [6.9 millimeters]. An ornamented shield characteristic of the genus was found near by and probably belongs to this species. It has a slight ridge along the middle, but is otherwise flat. The tubercles along the margin are somewhat larger than those near the center. This shield measures 8.7 millimeters long by 4 millimeters wide. Beside the above specimens a second jaw and some vertebrae were found.

Reference to Plate 19, Figures 1 and 2, will show the very fragmentary and unsatisfactory nature of the type material on which this species was established, and its specific distinctness from the other members of the genus can not be satisfactorily confirmed. Its small size will serve to distinguish it from all of the described species except *G. sphenodon* Marsh and *G. montanus* Douglass. The lack of homologous parts makes a comparison with the former impossible, as the type and only known specimen of *G. sphenodon* is a fragment of a maxillary bearing two teeth. These teeth are coequal in size with those of the dentary in *G. obtusidens* and closely resemble them in their transversely compressed crowns with smooth, nonstriated surfaces. The teeth differ from those of *G. montanus* in being slightly sharper and in their greater height above the alveolar border of the dentary.

On the basis of determinable specific characters this species should be abandoned, but since it comes from the Wasatch formation and is therefore the oldest species geologically as well as being the only described specimen of the genus from this formation, there would appear some justification for its retention in the hope that more diagnostic specimens will be discovered, and thus give the species a recognizable status.

The "second jaw and some vertebrae" mentioned by Loomis corroborate his determination of the *Glyptosaurus* affinities of the type, but the jaw adds nothing to our knowledge of the species. Two dorsal vertebrae accompanying the type specimens but without catalogue number are typically glyptosauroid in their general characters. They differ, however, from those of *G. sylvestris* in being relatively more depressed and with a more uniform transverse convexity of their ventral surfaces. Also there is no perceptible annular groove setting off the ball as in that species.

Measurements of vertebrae

	No. 1	No. 2
	Mm.	*Mm.*
Greatest length of centrum on ventral surface	10.5	9.0
Greatest width anterior end	12.5	12.0
Greatest width of cup	6.0	6.0
Greatest depth at center	7.0	6.7

To this species I tentatively refer specimen No. 5380, United States National Museum, which was assigned by Cope to the Placosauridae. This specimen, from the Wasatch formation of New Mexico, is of small size and has dermal scutes that are indistinguishable from the paratype of the present species. Cope's only mention of this specimen is given below:

> On several occasions osseous cranial and dermal scuta of lizards were obtained, but always in such a state of dislocation as to forbid the proper identification of the genera and species. They are ornamented on their superior surfaces by regularly-arranged tubercles, of a shining substance, resembling ganoine or enamel. The dermal scuta are rectangular and display a fine suture on their borders.
>
> The species probably belong to the Placosauridae of Gervais, whose remains have been found in the Eocene of Europe.

The principal features of the osseous scutes and fragmentary bones, consisting of the distal end of a quadrate, proximal two-thirds of a tibia, and numerous fragments are well shown in Plate 20, Figures 12 to 12j, after Cope.

REFERRED SPECIMENS

No. 5181, American Museum of Natural History. Consists of the anterior half of the coalesced frontals. Wasatch, Eocene, Arroyo Blanco, N. Mex. Collected by the American Museum Expedition of 1912. This may represent an undescribed species of *Glyptosaurus*, but for the present is tentatively referred to the present species. In size and general massiveness the frontals closely approach the type of *G. tuberculatus*. It is to be distinguished from that species, as well as from all others in which the scutal ornamentation of the frontals is known, by the presence on the anterior ends of the frontals of two large, irregularly hexagonal scutes which meet on the median line. The arrangement of the tubercles on the scutes most nearly resembles the condition found in *G. princeps*, having a tendency to arrange themselves in rows radiating from the center, as shown in Plate 15, Figure 6. The scutes, however, are higher and more conical than in that species. If correctly referred to *G. obtusidens* Loomis, the presence of the large scutes mentioned will be of the greatest assistance in distinguishing other frontal materials of this species. The pre- and postfrontal are separated above the orbit by the frontal, as in the other species of the genus.

No. 5176, American Museum of Natural History. Consists of portions of two dentaries and the anterior tip of the frontals. Collected by the American Museum Expedition of 1911 from the Wasatch, Eocene, Big Horn Basin, Wyo. About the size of *G. obtusidens*, but having most of the teeth sculptured. Tentatively referred to the present species.

GLYPTOSAURUS GIGANTEUS, new species

(Pl. 14, fig. 1)

Type specimen.—Carnegie Museum, catalogue No. 1471. Consists of the greater portion of the frontal region of the skull, covered with osseous dermal scutes. Collected by O. A. Peterson and J. A. Hermann, 1905.

Type locality.—Jim Creek, Sioux County, Nebr.

Horizon.—Oreodon beds, White River formation, Oligocene.

In the collection of the Carnegie Museum is the greater portion of the frontal region of a very large glyptosauroid lizard. On account of its great size and the character of the osseous scutellation covering the frontal, I consider this distinct from other species of the genus and propose the name *giganteus* for its reception.

This fragmentary portion of the skull measures 43.5 millimeters in length and 38 in width between the orbits. *G. hillsi*, which approaches nearest to it in size, measures only 27 millimeters between the orbits, so that *G. giganteus* is more than one-fourth larger. The greatest thickness of the frontal region is 15.5 millimeters; in *G. hillsi* it is only 10 millimeters. Both anterior and posterior borders present broken surfaces. Both prefrontals are missing, but small portions remain attached by suture to the frontal. However, it is plainly evident that the pre- and postfrontals were not in contact above the orbit but were separated by the interposition of the frontal, which, as usual, forms the median upper boundary of the orbit. Frontal bones coossified on the median line.

The dorsal surface of the frontals is covered by osseous dermal scutes of varying sizes, arranged in somewhat irregular longitudinal rows. These scutes are large but vary somewhat in form and size, most of them being five or six sided, with angular convex upper surfaces that are covered either with shallow pits or, in a few instances, with small tubercles, but without definite pattern. In the style of ornamentation, especially as regards the pitting, they more closely resemble *Heloderma* than any of the other species of *Glyptosaurus*.

Anteroposteriorly the plane of the frontals is gently convex; transversely it is nearly flat.

The fragmentary nature of the specimen precludes the possibility of discussing the affinities of the species with others of the genus. Its very large size, and the coarse sculpture of large dermal scutes will be sufficient to distinguish it, especially since most of the described specimens have portions of the frontal bones preserved.

Geologically this is the youngest and only species known from the Oreodon beds of the Oligocene.

GLYPTOSAURUS, species undetermined

Gyptosaurus, Gilmore, C. W., Mem. Carnegie Mus., vol. 7, No. 2, 1917, pp. 159, 160.

In the publication cited attention was first called to the presence of *Glyptosaurus* remains in the Uinta formation of Utah, as follows:

> A specimen, Carnegie Museum No. 3405, consisting of the greater part of the parietal with other fragments of the skull and lower jaws and a few shields, is identified as pertaining to the lizardlike reptile *Glyptosaurus*. It was collected by O. A. Peterson, August 24, 1912, on White River, near Ouray, Uinta Basin, Utah, from Horizon C, Uinta formation, Upper Eocene.
>
> The few osseous shields present are evidently from the trunk of the body. These are oblong quadrate, with a smooth, thinned-out anterior end, which is overlapped by the next plate of the series. The lateral borders are roughened for sutural union. The external surface, excepting the smooth area mentioned above, is ornamented with small rounded tubercles closely arranged in more or less concentric rows. The cranial shields on the parietal are of irregular sizes with their surfaces ornamented much in the same manner as the trunk shields.

This specimen may represent an undescribed species, but at the present time, on account of the very unsatisfactory type specimens upon which the nine described species have been based, it is impossible to make adequate comparisons, so that the specific determination of the present specimen must await the thorough revision of the species of the genus. It is of interest, however, as recording for the first time the occurrence of the genus *Glyptosaurus* in the Uinta formation, and also from the fact that it occurs intermediate geologically between the oldest known specimens from the Bridger described by Marsh and the youngest specimen discovered and described by Douglass from the Oligocene.[15]

As mentioned above, this specimen may represent an undescribed species, but its fragmentary condition precludes the possibility of definitely determining that fact. In size, as shown by the parietal, it represents a small species of about the dimensions of the type of *Glyptosaurus montanus.* The great variation in size of the scuttelation, however, and the flatness of many of the plates apparently distinguishes it from that species. The chief interest lies, therefore, in its being the first recorded occurrence of *Glyptosaurus* in the Uinta formation of the Upper Eocene.

A second fragmentary specimen of *Glyptosaurus* from the Uinta formation was found in the collection from the Princeton Museum (No. 11,303). It consists of fragments of a skull that are indistinguishable from the Carnegie specimen described above. This specimen was collected by J. B. Hatcher in 1895 from the "Upper gray clays," *T. cornutum* beds, Kennedy's Hole, White River, Utah.

Listed under catalogue No. 1618, American Museum of Natural History, as "unassociated scraps" are three dorsal vertebrae, portion of a parietal, and a dermal scute, all from the Upper Beds of the Huerfano, north of Gardner, Colo., and collected by the American Museum expedition of 1918. The very much smaller size of these and slight differences displayed in the ornamentation of the tubercles apparently indicate the presence in these beds of another but as yet unidentified species.

Sinclair and Granger, in the Bulletin of the American Museum of Natural History (vol. 30, 1911, p. 91), first reported the presence of *Glyptosaurus* (scutes) in the Wind River formation of Wyoming. Confirmation of this occurence is furnished by the two specimens noted below:

A fragmentary specimen, No. 1615, American Museum of Natural History, consisting of a few skull fragments covered with osteoderms, associated with many body scutes, was collected from the Wind River formation in Wyoming in 1909, and a second specimen, No. 5109, consisting of skull and jaw fragments, premaxillary, and a few vertebrae, and distal end of humerus (see pl. 11, fig. 3), was collected from the same formation and in the same year on Lower Alkali Creek, Wind River Basin, Wyo.

A thickened dermal head scute without catalogue number in the Victoria Memorial Museum, Ottawa, from the Oligocene of the Cypress Hills has the dorsal surface thickly studded with rounded enameled tubercles typical of the genus *Glyptosaurus.* It is the first time specimens of this genus have been recognized in the Cypress Hill fauna, and it is also of further interest as being the most northerly occurrence of this extinct lizard in North America.

No. 1285, Kansas University, consists of the median portion of a left ramus in which are the basal portions of several teeth. This specimen is provisionally referred to the genus *Glyptosaurus* and is of interest as being the first reported occurrence of this genus in northeastern Colorado. It was collected from the Pawnee Creek Beds, Oligocene, Pawnee Creek, Logan County, Colo. 1925.

Genus PELTOSAURUS Cope

Peltosaurus Cope, Paleont. Bull. No. 15, 1873, p. 5.

Genotype.—Peltosaurus granulosus Cope.

Characters.—Head and body covered with osteoderms having granular ornamentation; head scutes having a symmetrical arrangement as in existing lizards; median cranial scutes longer than wide; interoccipital constantly present; frontals united. Few teeth on pterygoid in single row; postorbital and postfrontal coalesced; parietal in contact with squamosal.

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[15] Douglass, Earl, Ann. Carnegie Mus., vol. 4, 1908, pp. 278–283.

Cope[16] referred *Peltosaurus* provisionally to the Gerrhonotidae (Anguidae of modern nomenclature), a reference which can now be made positive. His discussion as to the family relationships is as follows:

> The characters of the premaxillary bone, fontanelle, dentition, coronoid, dentary, splenial bones, and meckelian groove place this genus out of the pale of the acrodont families. The parietals and vertebre are distinct from anything known among the genus. There is no resemblance in essentials to the *Amphisbaenia*, so that we must look for its place among the numerous pleurodont families. Here the absence of knowledge of the periotic bones and sternum somewhat embarrasses us; but other indications are clear.
>
> The coincidence of the want of parietal fontanelle with the lateral frontal plates refers us at once to the Leptoglossa or Diploglossa, a reference confirmed by the simple frontal and strong cranial arches. The massive form of the surangular bone and reduction of the angular at once distinguishes *Peltosaurus* from any known family of the tribe Leptoglossa, and constitutes a point of near resemblance to the Gerrhonotidae. This appears to be a real affinity, which is further confirmed by the presence of a symmetrical dermal scutellation on the top of the head.
>
> Referring *Peltosaurus*, therefore, provisionally to the Gerrhonotidae, it remains to consider the generic characters. The temporal fossa was not roofed over by true bone, though the border of the postfrontal encroaches on it; and it is rather small. The orbits, on the other hand, are large, and the malar bone forms a segment of a circle. The parietal thins out behind, and its posterior border has a subround excavation. The two median dermal scuta, which left thin impressions on the parietal bone, represent the interparietal and posterior-parietal plates respectively; the latter especially characteristic of the Gerrhonotidae and not found in leptogloss or diplogloss families generally, those possessing it being the Lacertidae in the former and the Anguidae in the latter. The most prominent character which distinguishes this genus from *Gerrhonotus* is the existence of the osseous scuta which covered the body. Even the form of these is similar to the corresponding dermal scuta of the existing genus. They are rectangular and are arranged in transverse bands on the body, those of one row overlapping the bases of those of the next row posteriorly, or imbricated. The scuta of each row are joined on their long sides, by minute suture.

The anguid assignment of *Peltosaurus* has never been questioned, and the study of many specimens further substantiates the soundness of Cope's original observations.

Three species of this genus are now recognized, *P. granulosus* and *P. abbotti*, both from the Oligocene, and *P.? piger* from the Lance, Upper Cretaceous. The last named, based on meager materials, is assigned to the genus with some doubt. Specimens are also found in the Paleocene but the known materials are insufficient for specific determination.

Key to species

Typically of moderate size; skull of moderate width. Frontonasal bordered laterally by prefrontal and postnasal scutes	*P. granulosus.*
Typically of moderate size; skull broad, one-fourth wider than preceding species. Frontonasal scute bordered laterally by prefrontal scute only	*P. abbotti.*
Typically very small	*P. piger.*

Geologic distribution of the species of Peltosaurus

Period		Formation		Species
Oligocene		White River	Leptauchenia (Protoceras) zone	*P. abbotti, P. granulosus.*
			Oreodon zone	*P. granulosus.*
			Titanotherium zone	*Peltosaurus?*
Eocene	Upper	Uinta		
	Middle	Bridger	C	
			B	*Peltosaurus* sp.
			A	
		Wind River		
	Lower	Wasatch	Upper	
			Lower	
Paleocene		Fort Union		*Peltosaurus* sp.
		Torrejon		*Peltosaurus* sp.
		Puerco		
Upper Cretaceous		Lance		*P.? piger.*

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[16] Rep. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 772.

SYNOPSIS OF OSTEOLOGICAL CHARACTERS

Skull.—Parietal single, expanded with pineal foramen; frontals united; inferior plates of frontals well developed, but never inclosing olfactory lobes; nasals distinct; prefrontal extending above orbit but never meeting the postfrontal; postfrontal crescentric, united with frontal and parietal; postorbital always coossified with postfrontal, apparently excluded from orbital border; squamosal elongate, nearly reaching jugal; jugal heavy, rectangular, articulating principally with postorbital; tabulare present; premaxillary single; pterygoid with narrow row of teeth; supratemporal fossa roofed over by dermal scutes; quadrate with narrow internal wing.

Jaws.—Meckel's groove completely closed except at anterior end; surangular never extending forward as far as anterior suture of coronoid; splenial extensive posteriorly; angular with extensive external surface; surangular, articular, and prearticular coossified to form one bone; angle strong, directed inward; coronoid high with slight extension forward on external side.

Teeth.—Pleurodont; transversely compressed crowns, with beveled outer faces; posterior teeth blunt with low longitudinal ridge; crown surfaces smooth or striated. Dental formula, maxillaries 16 or 17, premaxillary 8, dentary 21.

Pectoral girdle.—Interclavicle cruciform; coracoid with two notches; scapula short, expanded.

Vertebrae.—Condylar articulation of dorsals transversely oval; centra moderately depressed; vertebrae without zygosphenal articulation; strong hypophysial keel on cervicals. Caudal vertebrae having chevrons attached to stout facets on posterior half of centra.

Dermal scutes.—Dermal scutellation covering head and body. Rectangular dermal scutes on body. Ornamentation of scutella granular. Squamation on head resembling recent lizards. Interoccipital constantly present.

PELTOSAURUS GRANULOSUS Cope

(Pl. 20, figs. 1 to 9; pl. 22, fig. 3)

Peltosaurus granulosus Cope, E. D., Paleont. Bull. No. 15, Aug. 20, 1873, p. 5; Synop. new Vert. from Tertiary of Colorado, Washington, October, 1873, p. 19; Ann. Rep. Geol. and Geogr. Surv. Terr. for 1873, 1874, p. 513; Proc. Acad. Nat. Sci. Philadelphia, 1874, pp. 116, 117; Rep. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 773, pl. 60, figs. 3–11.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Douglass, Earl, Ann. Carnegie Mus., vol. 4, 1908, pp. 284, 285, text figs. 6–8.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 44.

Type specimen.—American Museum of Natural History, catalogue No. 1610. Consists of the premaxillary, median part of one maxillary, jugal of the left side, coossified frontals, parietal, greater part of both mandibular rami, three vertebrae, and many dermal scutes, ribs, and skull fragments. Collected by E. D. Cope, 1873.

Type locality.—Cedar Creek, Logan County, Colo

Horizon.—Cedar Creek beds, Oreodon zone (horizon B or C, of Hayden and Leidy), White River formation, Oligocene.

Original description.—Char. specif. Parietal bone broad and flat, frontal little narrowed, gently convex, both with finely granular upper surface. Scuta not keeled, finely granular. Number of teeth on premaxillary bone 7; teeth on dentary 10 in M. 0.010. Surface of the dentary smooth.

Measurements

	M.
Median width of parietals	0. 014
Median width of frontals	. 008
Length mandibular ramus to cotylus	. 040
Diameter vertebral centrum (transverse)	. 003
Length vertebral centrum	. 0055

Size about that of the American *Heloderma.* The genus is allied to the *Glyptosaurus* of Marsh.

In his *Tertiary Vertebrata* Cope gives the following more detailed description:

> The parietal is a wide element, and has a nearly plane superior surface. The granular sculpture vanishes posteriorly, leaving a wide, smooth band at the posterior border of the bone. The scutal areas are rather narrow, each one longer than wide, and occupying just half of the length of the granular portion of the surface. The frontal suture is perfectly straight. The frontal bone is longer than wide, and is slightly convex in both directions. The greater part of it is preserved, and displays no dermal scuta, hence the frontal al scutum was large and undivided. The lateral olfactory ridges are massive and not very deep, being much thicker than in *Exostinus serratus,* and are strongly beveled on the external side; that is, to the supraorbital border. The malar and postorbital bones together form a rather slender arc of a circle, indicating a large orbit. The premaxillary bone has a wide, flat spine, which is so strongly inclined as to be nearly horizontal. No portion of it protrudes beyond the alveolar border, which supports seven teeth. There is a foramen at the base of the spine on each side. The external surface of the premaxillary is entirely smooth. On the external face of the maxillary the usual foramina occur at the usual intervals. In the mandible the post dentary parts are extended, about equaling the dentary (the angle is broken from both rami), and are robust. The anterior fourth of the meckelian groove is exposed. The external face of the dentary is convex, and is pierced by five foramina, all in the anterior half. The superior aspect of the surangular region is truncate or flattened, with angles separating it from the lateral faces, as in other *Gerrhonotidae.*
>
> There are 10 teeth in 0.10 millimeter of the maxillary bone, and there are 24 in the dentary bone; all are closely placed. Those of the superior series are a little more robust; their inner faces are convex, giving the shaft a slight curve in profile. The apices of the teeth are not expanded, but are wedge-shaped, with a cutting edge in the long axis of the jaw. A strong bevel of the crown to the external maxillary face gives their apices an especial robustness. Under the microscope their surface is delicately parallel—wrinkled to the cutting edge.
>
> The scuta are parallelogrammic in form, and their proximal or concealed portions are from one-fourth to one-third the entire length. The granulation is like that of the cranium, fine and without distinct pattern.
>
> The centra of the vertebrae are moderately depressed, those of the dorsal region the most so, and with the greater part of the face of the ball looking upward. These centra are not ridged on the middle line below, but are slightly convex in transverse section. On either side, behind the inferior extremity of the parapophysis, is an open, shallow groove looking downward, and defining the middle region as a wide band. Above, this groove is bounded by an obtuse longitudinal ridge, and above the ridge occupying the side of the centrum is a concavity. This is bounded above by the prominent ridge that connects the zygapophyses. The transverse process is vertical and narrow; it is nearly sessile and is not subdivided. A vertebra inclosed in matrix close to the skull is probably from the anterior part of the series. Its centrum is not so depressed as in those already described, and it has a strong hypapophysial keel. Its ventral spine is rather elevated, and is grooved posteriorly.
>
> As compared with the so-called *Placosauridae* of the Eocene formation, this species presents various points of resemblance, which the description of the former do not yet permit us fully to estimate. The presence of regular cranial scuta will distinguish *Peltosaurus* from the known forms as a genus. The granulation of the cranium and osseous scuta is finer than in any of the Eocene species I have met with.

OSTEOLOGY OF THE SKELETON

The osteological structure of the genus *Peltosaurus,* based primarily on the type of *P. granulosus* Cope, is splendidly supplemented by a considerable number of specimens. A comparative study of these enables me to give below a detailed description of the skull and jaw structure, to add some information to Cope's description of the vertebrae, and for the first time to throw some light on the composition of the pectoral girdle. With all of these specimens not a fragment of a limb or foot bone, with the exception of a humerus (see p. 134), is preserved, so that we have no knowledge of these important parts of the skeleton.

SKULL

The description of the bones of the skull of *Peltosaurus granulosus* is based primarily on the fragmentary type specimen. A nearly perfect skull of this species, together with several partial skulls which beautifully supplement one another, are now available for study and leave very little of the cranial structure to conjecture. It is normal lacertilian in all respects. The form and contour can be accurately described from the excellently preserved skull loaned by the Kansas University Museum (No. 1280). This is practically free from distortion, and the very skillful preparatory work of Mr. Handel T. Martin has completely freed the skull and lower jaws from the investing matrix, thus bringing to light all of their detailed structure. This and two other specimens, No. 11393, Princeton Museum, and No. 1061, Yale Museum, show a great number of the osseous scutes, so that from all it has been possible for the first time to work out a considerable part of the scutellation of the top and side of the head. (See fig. 76.)

Viewed from above the skull is triangular, broad behind, and with a blunt, rounded muzzle. Skull moderately depressed. An adult skull (No. 1280, Kansas University Museum) has a greatest length from the tip of the nose to the posterior end of the squamosal of about 48 millimeters, a greatest width of about 28 millimeters, and a greatest vertical depth with the lower jaws of over 19 millimeters. With the supraorbital scutes removed the orbits are large and nearly circular. (See fig. 75, and pl. 22, fig. 1.) Viewed from the side, the top of the head is flat, but from the center of the orbits to the end of the snout is strongly convex in profile. In life the entire top and sides of the head were covered with osseous scutes whose surfaces have a granulated sculpture. On the parietal and frontal regions the scutes are usually securely ankylosed to the underlying bones, but the lateral scutes are not so firmly joined and in most specimens are found detached.

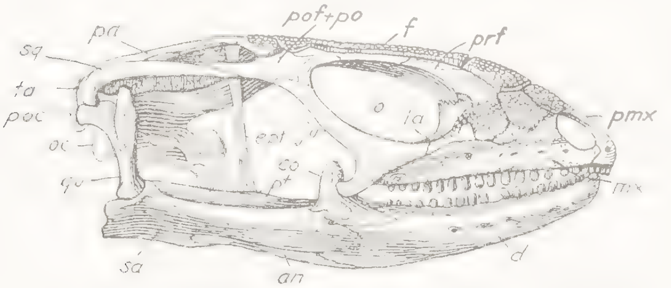

FIG. 73.—Skull of *Peltosaurus granulosus* Cope. (No. 1208, Kansas University.) One and one-half times natural size. Viewed from the right side. *an*, angular; *co*, coronoid; *d*, dentary; *ept*, epipterygoid; *f*, frontal; *ju*, jugal; *la*, lachrymal; *mx*, maxillary; *o*, orbit; *oc*, occipital condyle; *pa*, parietal; *pmx*, premaxillary; *poc*, paroccipital; *pof+po*, postfrontal+postorbital; *prf*, prefrontal; *pt*, pterygoid; *qu*. quadrate; *sa*. surangular; *sg*. squamosal; *ta*, tabulare. Posterior end of ramus missing

Parietal.—The parietal bone is present in the type, completely preserved except for the missing divergent posterior processes. These, however, are present in specimens No. 1280, Kansas University Museum, and No. 11392, Princeton Museum. (See pl. 21, fig. 1.) The parietal is a wide bone having a nearly plane superior surface that is usually covered with coossified scutes having a granular ornamentation. This granular sculpture, however, vanishes along the posterior border of the parietal, leaving a narrow band of smooth bone. At the center the posterior border is indented by a U-shaped notch of moderate depth. On either side of the notch the parietal is produced backward as two slender divergent processes which unite laterally with the tabulare of either side. The frontal border is straight. The presence of the tabulare is clearly shown in specimen No. 1208, Kansas University Museum. (See *ta*, fig. 73.) It is missing in all of the other skulls examined with the exception of No. 425, Carnegie Museum (see fig. 74), but that it was present in these is indicated by the external longitudinally grooved borders of the parietal processes.

The main part of the upper surface of the parietal is covered by four scutes, which, as stated before, are usually firmly coossified to it. All are longer than wide. The interparietal is very narrow posteriorly and extends forward slightly over the frontoparietal suture, terminating in a V-shaped point (See fig. 76) above the frontal bone. Near its median posterior border a small pineal foramen perforates the bone, as is clearly shown in the parietal of the type specimen, but which Cope failed to detect because of insufficient preparation. Its position is similar to that in *Gerrhonotus*. (See fig. 84.) Posterior to the interparietal is a second scute that has a narrow anterior end that gradually widens posteriorly and may be called interoccipital. This median pair is bordered on either side by the large parietal scutes. The median width of the parietal of the type is 14 millimeters and the median length is 12 millimeters.

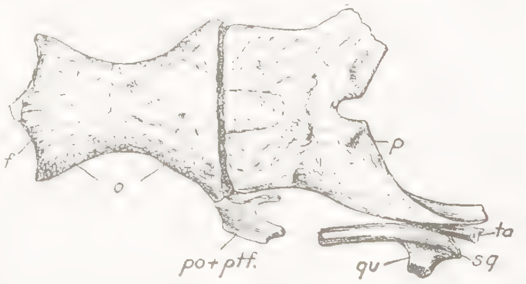

FIG. 74.—Skull of *Peltosaurus* sp. (No. 425, Carnegie Museum.) About one and one-half times natural size. Viewed from above. *f*, frontal; *o*, orbit; *p*, parietal; *po+ptf*, coossified postorbital and postfrontal; *qu*, quadrate; *sq*, squamosal; *ta*, tabulare. (After Douglass)

Frontals.—The frontal bone of the type lacks its posterior border (see pl. 20, fig. 1) and on that account the description will be supplemented by observations based on the Kansas University specimen (No. 1208) and Princeton specimen (No.11393), which are coequal in size. The coossified frontal bones are longer than wide and slightly convex both longitudinally and transversely, except the posterior end which is slightly concave transversely. It unites with the parietal by a straight transverse suture and with the paired nasals by a broad,V-shaped suture, the bone being beveled off above and extending well in under the overlying posterior ends of the nasals. Laterally it articulates with the pre- and postfrontals, and, as in *Gerrhonotus* and *Glyptosaurus*, these do not meet above the orbit but are separated by a space of 4 millimeters in the Kansas University specimen, which constitutes the frontal contribution to the orbital border. Describing the ventral side of the frontal of the type, Cope states: "The lateral olfactory ridges are massive and not very deep, being much thicker than in *Exostinus serratus,* and are strongly beveled on the external side; that is, to the supraorbital border." The anterior ends of the olfactory ridges are in contact with an upwardly directed process of the palatines as in *Gerrhonotus*. Laterally the nasals are notched for the articulation of the post- and prefrontal bones. The superior surface is covered by three scutes, a pair of frontoparietals posteriorly, and a single large frontal scute covers the remainder of the bone. (See fig. 76.) The missing posterior part of the frontal bone of the type led Cope into the error of thinking there was but a single scute covering the entire bone.

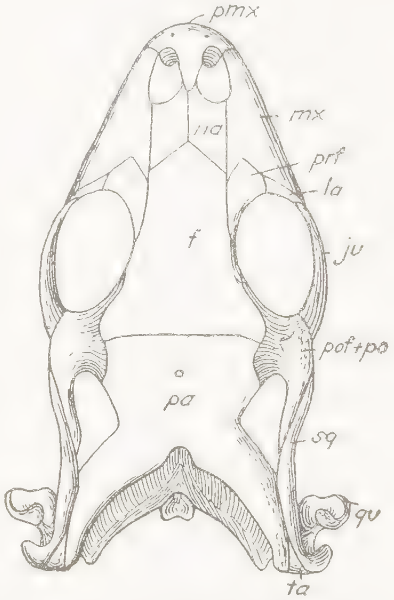

FIG. 75.—Skull of *Peltosaurus granulosus* Cope. Based principally on No. 1208, Kansas University. One and one-half times natural size. Cranial scutes removed in order to show the skull structure. *f*, frontal; *ju*, jugal; *la*, lachrymal; *mx*, maxillary; *na*, nasal; *pa*, parietal; *pmx*, premaxillary; *pof+po*, postfrontal+postorbital; *prf*, prefrontal; *qu*, quadrate; *sq*, squamosal; *ta*, tabulare

Nasals.—The nasals of this species are best preserved in specimens No. 1280, Kansas University Museum, and No. 1061, Yale Museum, which show them to be paired, relatively short bones with long, slender, pointed extremities on their medial anterior ends that embrace the pointed, posteriorly directed spine of the premaxillary. Laterally they join the maxillae and possibly the prefrontals. The extent of the union with the prefrontal, however, is obscure in all the specimens available, but it would appear that, if meeting at all, their contact is slight, as a posteriorly directed spur of the maxillary is interposed between the prefrontal, frontal, and nasal at their junction. (See fig. 75.) The only possibility of these bones being in contact would be that the nasal extends outward above the spur and lies upon the anterior dorsal surface of the prefrontal.

The nasals are covered by a median diamond-shaped frontonasal and by two irregularly shaped prefrontal scutes, in front of which are smaller postnasal scutes. The large size of the frontonasal and the presence of a single large prefrontal are features that distinguish the present species from *P. abbotti*.

Premaxillary.—The premaxillary bone (see pl. 20, fig. 1) has a flat triangular shaped spine which is inclined at an angle of about 45° to the horizontal. There is a foramen at the base of the spine on each side. The alveolar border is short and is so overlapped above by a process of the maxillary that it forms but a small part of the inferior narial border. The type premaxillary supports eight teeth instead of seven as observed by Cope, and specimens No. 1280, Kansas University, and No. 1061, Yale Museum, show an equal number. In the type of *P. abbotti*, No. 12861, Field Museum of Natural History, the teeth are all missing except the bases of a few, and from the spacing of these it would appear that the complete premaxillary series would consist of not less than eight teeth. In a specimen of *Glyptosaurus*, No. 5109, American Museum of Natural History, there are eight premaxillary teeth. The external surface of the premaxillary is smooth though in life it was probably also covered with its quota of dermal scutes, but these are now missing in all available specimens.

Maxillary.—The maxillary bone is represented in the type by the median part of the right element which bears seven complete teeth. Six of these which are in series occupy a space of 7.8 millimeters. The characters of this bone will be described from specimen No. 1061, Yale Museum (see pl. 21, fig. 3), which has the right maxillary completely preserved.

In outline the maxillary has the usual subtriangular shape, although the posterior extremity is especially slender and produced well backward under the orbit. Anteriorly it widens vertically and above meets the prefrontal and frontal, and is slightly in contact with the nasal. A pointed, posteriorly directed process of the maxillary is interposed between the anterior ends of the frontal and prefrontal, as shown on the left side of specimen No. 1061, Yale Museum. The forward end of the maxillary is excavated and forms the posterior boundary of the external nares. Its lower anterior extremity widens out to form a part of the floor of the nasal opening. (See fig. 76.) From the posterior side of this widened end a slender pointed spur extends in behind the premaxillary at the base of the spine, while from the anterior side a shorter process overlaps the lateral alveolar portion of the premaxillary. The long, tapering posterior extremity underlaps the lachrymal and jugal, reaching nearly to the posterior border of the orbit. The maxillary carried from 16 to 17 wedge-shaped pleurodont teeth. In No. 1061, Yale Museum, these occupy a space of 19.7 millimeters. The greatest length of the maxillary in the same specimen is about 22 millimeters.

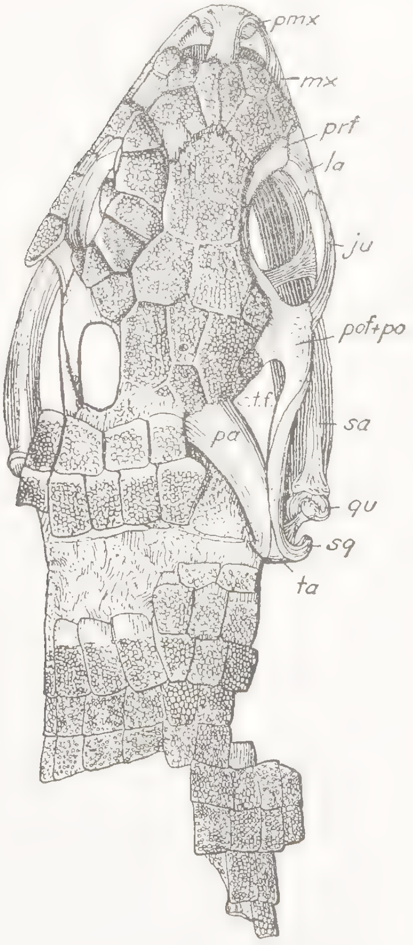

FIG. 76.—Skull of *Peltosaurus granulosus* Cope. (No. 1208, Kansas University.) One and one-half times natural size. Viewed from above showing the scutellation of skull and neck. *ju*, jugal; *la*, lachrymal; *mx*, maxillary; *pa*, parietal; *pmx*, premaxillary; *pof+po*, postfrontal+postorbital; *prf*, prefrontal; *qu*, quadrate; *sa*, surangular; *sq*, squamosal; *s. t. f.*, supratemporal fossa; *ta*, tabulare

Prefrontal.—The prefrontal is missing in the type but is present in several of the referred specimens, which collectively clearly show its principal characteristics and relationships. The prefrontal is subtriangular in outline. Its posterior extension along the side of the frontal terminates slightly forward of the center of the supraorbital border. Anteriorly it is in contact with the maxillary and lachrymal bones, and slightly, if at all, with the nasal. Inferiorly it is excluded from contact with the jugal by the interposition of processes of the lachrymal and palatine which effectually separate it. On the lower internal side it abuts against an upstanding process of the palatine. In this respect *Peltosaurus* differs from the living *Gerrhonotus*, which has the jugal and prefrontal in contact on the internal side of the lachrymal. These relationships are beautifully shown in specimen No. 1060, Yale Museum.

Postfrontal + postorbital.—The triradiate postfrontal appears to articulate about equally with the parietal and frontal at their junction by an inner median cupped border as in *Saniwa ensidens* Leidy. (See fig. 37.) The inferior projection for articulation with the postorbital is abbreviated, and in none of the skulls of the species am I able to detect the presence of a distinct postorbital, though this bone exists as such in the type of the closely allied *Melanosaurus maximus* (No. 5168, American Museum of Natural History, see fig. 88).

On the right side of specimen No. 391, Walker Museum, the postfrontal is apparently fully coalesced with the postorbital, as it is in the living Varanidae. In most Anguidae, however, these elements remain distinct. The postorbital of this complex, as shown by the same specimen, sends backward a relatively short, slender, tapering process to meet the squamosal. Inferiorly it joins the jugal by a diagonal suture. (See fig. 73.) In *Melanosaurus maximus*, as mentioned above, the postorbital is the smaller of the two bones, but no trace of their union can be detected in specimen No. 1208, Kansas University.

Lachrymal.—The lachrymal in *Peltosaurus* is narrow but elongate in lateral view. It is extended even farther posteriorly than in *Gerrhonotus* where it meets the jugal by a diagonal suture. Internally it develops a short process that is interposed between the inner anterior end of the jugal and the base of the prefrontal, and completely separates these two elements. The inner end of this process is in contact with the palatine. These relationships are to be clearly observed within the left orbit of specimen No. 1060, Yale Museum. There is a large lachrymal foramen which, posteriorly at least, takes the form of a vertically elongated notch on the median internal side. The inner boundary of this foramen is formed by the outer side of the prefrontal. The anterior end of the lachrymal is somewhat expanded and lies in a slight depression on the side of the prefrontal.

Jugal.—The jugal, shown best in specimen No. 11393, Princeton Museum (see pl. 21, fig. 2), is a slender, curved bar forming most of the lower and posterior boundary of the orbit. Anteriorly it joins the lachrymal. A prominent blunt spur projects backward from the posterior border at the point where it bends upward to the back of the orbit. Its upper extremity meets the postorbital by an oblique suture that is highest on the posterior side. In cross section it is triangular both above and below the posteriorly directed spur. This spurlike process is much more prominently developed than in the living *Gerrhonotus scincicauda* but approaches more nearly *G. imbricatus* as figured by Siebenrock.[17]

Squamosal.—The squamosal is best shown in the Kansas University specimen, on the right side. It is a compressed bar that curves downward at the posterior end and articulates internally with the tabulare. Anteriorly it joins the posterior branch of the postorbital by squamous suture to form the slender supratemporal arcade. The anterior prolongation of the squamosal is unusual in nearly reaching the jugal; in fact, the Princeton specimen appears to show them in contact, but this may have been brought about by slight displacement, as they are not in contact in the better-preserved Kansas University specimen. This bone in No. 11393, Princeton Museum, has a greatest length of 18 millimeters. The unusual length of this bone is, so far as known, exceeded only in *Melanosaurus*.

Quadrate.—The quadrates are both present in specimen No. 1208, Kansas University, the right one being perfectly preserved, showing for the first time the complete details of this important element. In its main characteristics it closely resembles the quadrate of *Gerrhonotus*. Its anterior external border is produced strongly outward, then backward, thus forming a longitudinal cavity which is wider above than below. (See fig. 77.) The anterior border is likewise produced inward from the main mass of the bone, but to a lesser degree, though relatively it has a greater expanse than in the living *Gerrhonotus*. In the last respect it differs strongly from *Melanosaurus* in the absence of a rounded, winglike extension of the upper part of this border. The column near the top is produced backward thus giving the posterior border a concave appearance when viewed laterally. The mandibular articulation is bilobate. In the Iguanidae, as pointed out by Cope, "there is another concavity internal to the column, similar to the external," but in the Anguidae it is narrower and less concave than the outer. In specimen No. 1208, Kansas University, the quadrate has a greatest length of 9.5 millimeters. The inclination of the quadrate in the articulated skull is slightly backward as in *Gerrhonotus*, as shown in Figure 73.

Tabulare.—The literature on this bone is highly confusing, as pointed out by Camp.[18] "By Zittel, Baur, and Watson it is regarded as the true squamosal; by Hoffman, Cope, and Siebenrock it is called supratemporal; by Sollas, prosquamosal, and by Williston and by Broon the tabulare."

The position of this element is constant enough in lizards to be easily recognizable, and I shall therefore follow Williston, Broom, and Camp in designating it the tabulare.

The Kansas University specimen clearly demonstrates the presence of a well developed tabulare in the genus *Peltosaurus*, as shown in Figure 75. It is also present in a specimen belonging to the Carnegie Museum, figured by Douglass [19] (see fig. 74), but was unrecognized at that time. The element is missing in all of the other *Peltosaurus* skulls now before me, but in specimen No. 11393, Princeton Museum, a longitudinal depression along the right lateral border of the parietal clearly indicates the area of attachment for the tabulare.

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[17] Ann. K. K. Naturhist. Hofmuseum, vol. 7, pt. 3, 1892, pl. 12, fig. 8b.

[18] Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, p. 346.

[19] Annals Carnegie Mus., vol. 4, 1908, p. 284, fig. 6.

The tabulare is a tapering, splintlike bone that in the articulated cranium is intercalated between the posterior process of the parietal and the squamosal, and with them forms the articulation for the quadrate. Its anterior extremity is closely applied to the lateral border of the perietal and thus contributes to the inner boundary of the supratemporal fossa. The upper lateral edge of the parietal is produced outward above the tabulare and thus excludes all of it except the posterior end from a superior view. The posterior end is thickened transversely and turns downward between the paroccipital process and the squamosal. Its under side caps the quadrate and furnishes the main support to that bone. Posteriorly it is subequal in length with the squamosal and slightly longer than the lateral process of the parietal.

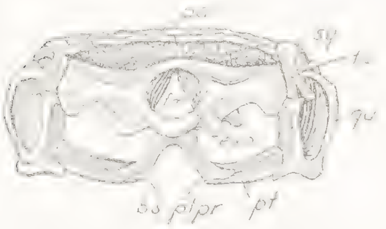

FIG. 77.—Skull of *Peltosaurus granulosus* Cope. (No. 1208, Kansas University.) One and one-half times natural size. Posterior view. *bs*, *ptpr*, basipterygoid processes; *exo*, exoccipital; *fm*, foramen magnum; *pa*, parietal; *pt*, pterygoid; *qu*, quadrate; *sq*, squamosal; *ta*, tabulare

Epipterygoid.—The epipterygoid (see fig. 73) is a slender, rounded bar with slightly expanded ends. Its base is received in a pocket on the top of the pterygoid, the top being in contact with the under side of the parietal. It has a greatest length of about 12 millimeters.

Opisthotic and proötic.—The side walls of the skull are formed by the otic bones, but all are so thoroughly coossified that their limits can not be determined. The overlying parietal does not unite suturally with the proötic bones but were connected with them by fibrous tissue. As in all living lizards the presphenoidal region remains unossified. On either side of the pineal foramen the parietal bone develops two thin perpendicular ridges of bone which are produced downward and backward into processes that articulate with the anterior ends of the proötic prolongation. This contact is at a point behind the epipterygoid bar when viewed from the side.

Occipital region.—The Kansas University specimen presents for the first time in the genus *Peltosaurus* the complete posterior or occipital region, as shown in Figure 77. The elements of the occiput are all so thoroughly coossified that their sutural contacts can no longer be determined. The occiput is wide transversely but very narrow vertically. The foramen magnum is subcircular in outline and relatively large. The occipital condyle is reniform and relatively small as in *Gerrhonotus* and *Ophisaurus*. It is presumed that the exoccipitals contribute to the formation of the condyle but the coalescence of the sutures does not permit of a determination of this fact. The exoccipitals form the lateral boundaries of the foramen magnum, but are widely separated above by the interposition of the large supraoccipital. The paroccipital processes extend outward and slightly backward, terminating in vertically expanded ends that are in contact with the tabulare and quadrate bones. The supraoccipital-exoccipital sutures can be quite certainly determined as running slightly forward and outward from either side of the top of the foramen. The supraoccipital forms the median upper boundary of this opening and, as in the living *Gerrhonotus*, is but little inclined upward. It is strongly overhung by the parietal. Matrix obscures its anterior extremity but that these bones had a loose articulation as in other members of the Anguidae, is quite certain.

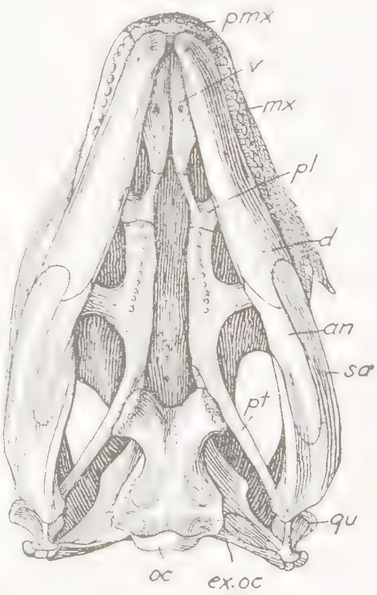

FIG. 78.—Skull of *Peltosaurus granulosus* Cope. (No. 1208, Kansas University.) One and one-half times natural size. Viewed from below. *an*, angular; *d*, dentary: *exoc*, exoccipital; *mx*, maxillary; *oc*, occipital condyle; *pl*, palatine; *pmx*, premaxillary; *pt*, pterygoid; *qu*, quadrate; *sa*, surangular; *v*, vomer

Palate.—The nearly complete palate is excellently shown for the first time in the Kansas University specimen. (See fig. 78.) The posterior part of the palate is also preserved in specimen No. 11393, Princeton Museum. Viewed from below the basisphenoid and basioccipital, which are fully coossified, present a median triangular area of bone whose apex is directed forward. The well-developed basioccipital processes in the Princeton specimen are joined by an obtuse transverse ridge, and in front of this ridge is a subtriangular depression. A similar condition exists in the allied *Melanosaurus maximus*, whereas in *Gerrhonotus* there is no connecting ridge and the anterior area is decidedly convex from side to side. In the Kansas specimen this ridge is also absent but otherwise is quite in accord with the Princeton specimen described above. The basipterygoid gives off near its anterior termination well-developed pterygoid processes that have dilated extremities which articulate with longitudinally elongated facets upon the pterygoids. (See fig. 78.) The pterygoid bones extend forward from the quadrates, with which they are in contact, toward the middle line. They are in contact on their inner sides with the basipterygoid processes, forward of which they diverge and assume a longitudinal position, without meeting on the median line. The barlike portion of the pterygoids posterior to the basipterygoid processes is longitudinally grooved on the inner side. Anteriorly their transversely widened ends join the palatines. Somewhat posteriorly a thin, divergent process is given off directed toward the posterior extremity of the maxillary from which it is separated by the interposition of the small ectopterygoid. In *Peltosaurus* the pterygoids bear a longitudinal row of 10 or 12 tubercularlike teeth. The palatine bones are widely separated from each other on the median line. Anteriorly they join the vomers, and laterally develop a process that turns outward and forward to join the maxillary. The vomers are distinct but closely applied along the median line only, their posterior ends being separated by a fissure. The forward ends are received in a broadly concave notch on the back of the premaxillary. These bones form the median separation between the internal narial openings. Their median inferior surfaces are concavely hollowed out but not so deep as in *Gerrhonotus*. The ectopterygoids occupy their usual position wedged in between the outer process of the pterygoid and the maxillary bone. In the illustrations they are hidden from view by intervening bones.

Measurements of skull No. 1208, Kansas University

	Mm.
Greatest length over all	48. 0
Greatest width across tops of quadrates (about)	29. 0
Greatest width across center of jugals	28. 0
Greatest width across center of anterior nares	10. 0
Greatest width of parietal at center	11. 0
Greatest width of frontal at center	7. 0
Greatest height of skull with lower jaws	19. 0
Diameter of orbit with scutes anteroposteriorly	11. 4
Diameter of orbit without scutes anteroposteriorly	12. 5
Vertical diameter of orbit without scutes	10. 0
Vertical diameter of orbit with scutes	5. 7
Greatest length of quadrate	9. 5
Greatest length of squamosal	15. 5
Greatest length of frontal	17. 5
Greatest length of parietal	21. 0
Greatest width of occipital condyle	4. 5

LOWER JAW

The lower jaw in *Peltosaurus granulosus* is represented in the type specimen by the greater portions of both rami. Both angles are missing and the surfaces of the bones are badly shattered, thus obscuring many of their details. Fortunately, portions of one or both rami are present with the skulls previously described, and these, with the several detached jaws present, show the entire detailed structure of the lower mandible. Specimen No. 1208, Kansas University, has both rami in proper position in relation to the jaws. (See fig. 78.) Both have suffered the loss of their posterior extremities but otherwise are perfectly preserved. The right ramus of specimen No. 1061, Yale Museum, is the most complete, but it is so intimately attached to the skull that it was feared permanent damage might be done if its removal was attempted. This complete ramus shows that the postdentary parts are slightly more extended than the dentary portion. (See fig. 79.) It also brings out the great inflection of the postdentary portion which presents a wider ventral surface than the lateral view. Its extreme length is 46 millimeters.

Dentary.—The angular and surangular join the dentary by an irregular vertical suture, the main contact being with the latter bone. This suture lies below the center of the coronoid, whereas in *Gerrhonotus* it is in advance of the coronoid. Viewed laterally the vertical depth of the dentary is greatest at the posterior end and gradually narrows toward the front, the anterior end rounding up to the alveolar border. (See fig. 79, B.) The external surface is angularly convex and is pierced by a row of five foramina, all on the anterior half. Leading forward on the upper lateral face from the notch for the coronoid is a shallow but distinct longitudinal channel that gradually fades out on the anterior half. On the internal side Meckel's groove rapidly narrows anteriorly, continuing to the symphysis as a very narrow open slot on the internal ventral border. The dentary carries 21 pleurodont teeth and not 24 as stated by Cope. The type as well as two other specimens agree in this. There is but little incurvature of the anterior end and the symphysial union is weak.

Surangular.—The surangular is distinct from the angular but so closely coossified with the articular + prearticular that their sutural union can no longer be detected. From a superior aspect the surangular is flattened, an acute angle separating it from the inferior portion which assumes an almost horizontal position in the articulated jaw. On the anterior inferior surface it articulates with the relatively small angular, and anteriorly with the dentary and coronoid. Internally it meets the splenial and prearticular.

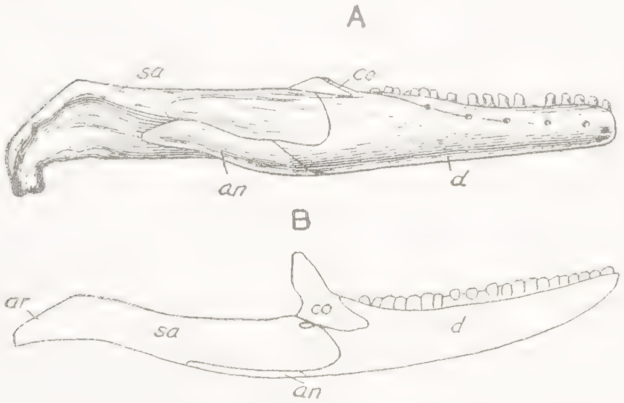

FIG. 79.—Right ramus of *Peltosaurus granulosus* Cope. (No. 1061, Yale Museum.) About one and one-half times natural size. A, oblique view from below; B, direct outer view; *an*, angular; *ar*, articular; *co*, coronoid; *d*, dentary; *sa*, surangular

Angular.—The angular is small, mostly external, the inward inflection of this portion of the ramus throwing it well under so that in the articulated jaw but little is visible from a lateral view. (See fig. 79B.) Its full extent is best shown in Figure 79A, where the mandible is rotated.

Articular + prearticular.—This complex I am unable to differentiate, nor can I determine the line of separation with the surangular. The angle is probably formed by the articular and is relatively thin dorsally-ventrally, with a slightly thickened extremity that turns decidedly inward. (See fig. 79A.) The posterior end of the ramus is diagonally truncated to its longer axis. The cotylus is wide and well defined, overhanging the internal side of the ramus.

Coronoid.—The coronoid straddles the posterior end of the dentary with its internal, forwardly directed process exceeding the outer in length. It rises well above the superior surface, the extension above about equaling the width of the ramus below this bone. Posteriorly the coronoid passes diagonally backward to the inside of the surangular where it is in contact with the prearticular portion of the articular complex. Anteriorly it meets the splenial.

Splenial.—The splenial is the usual thin bone closely applied to the internal side of the dentary and covering Meckel's groove except for a short distance posterior to the symphysis. It rapidly narrows anteriorly, becoming very slender anterior to the middle of the dentary. Posteriorly it extends back of the surangular-dentary suture.

TEETH

The dental formula of *Peltosaurus granulosus*, as near as can be determined from available materials, is as follows:

$$\frac{\text{Maxillary 16 or 17} + \text{premaxillaries 8}}{\text{Dentary 21}} = \frac{40 \text{ or } 42}{42}$$

Cope says "there are 24 teeth in the dentary bone" but I fail to find evidence of more than 20, possibly 21, in the right dentary of the type. In No. 12861, Field Museum, there are apparently 21, and I find an equal number in No. 1061, Yale Museum, and No. 1208, Kansas University.

The teeth are pleurodont, placed close together, with long subcylindrical shafts that are hollow as in *Gerrhosaurus*. Those of the superior series appear a little more robust than the inferior. The apices of the teeth are not expanded but are bluntly wedge-shaped with the cutting edge in the long axis of the jaw. The inner bevel of the crown is much longer than the outer and its surface is sometimes worn concave. Under the microscope the teeth of the type specimen are shown to have on the outer as well as the inner beveled surface delicate parallel wrinkles that run at right angles to the cutting edge. Except that the teeth become smaller at the ends of the series, all are very similar. In shape and crown sculpture they are so similar to those of some species of *Glyptosaurus* as to be indistinguishable.

In a space of 10 millimeters there are 9 teeth in the maxillary bone and a similar space on the dentary shows nearly the same number.

SCUTELLATION OF THE HEAD

Three specimens in the assembled material supplement one another so well as to give the arrangement of the dermal scutes over the greater part of the top of the head, as shown in Figure 83. The lateral scutes are not so fully known but are most completely shown in the type of *Peltosaurus abbotti*. The nomenclature used for the designation of these scutes is that of modern herpetologists, and is explained in Figure 80, reproduced from Stejneger.[20]

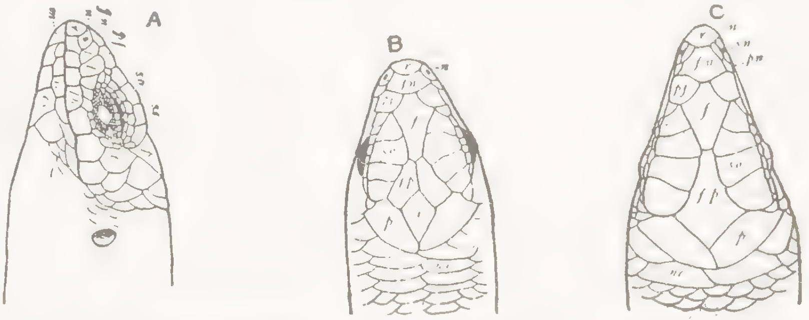

FIG. 80.—Head shields of scincid lizards. Enlarged. A, side view of head of *Leiolopisma*; B, upper view of head of *Leiolopisma*; C, upper view of head of *Emoia*. *cs*, chin shield; *d*, disk of lower eyelid; *e*, ear opening; *f*, frontal; *fn*, frontonasal; *fp*, frontoparietal; *i*, interparietal; *il*, lower labials; *l*, loreals; *lb*, upper labials; *m*, mental; *n*, nasal; *nc*, nuchals; *p*, parietals; *pf*, prefrontal; *pn*, postnasal; *r*, rostral; *sc*, supracillaries; *sn*, supranasal; *so*, supraocular; *t*, temporal. (After Stejneger)

The rostral and nasal scutes are missing in all of the specimens at hand. A large diamond-shaped frontonasal scute is clearly shown in specimen No. 1208, Kansas University (fig. 76), less clearly in No. 11393, Princeton Museum, and very indistinctly in No. 1061, Yale Museum. In two of these specimens this scute is divided by suture on the median line (see fig. 76), furnishing an additional difference between this species and *P. abbotti* where it is single. It is flanked on either side by the large polygonal prefrontals in *P. abbotti* (see fig. 83), which, in the two specimens last mentioned, nearly if not quite meet on the median line and may exclude the frontonasal from contact with the frontal. Anteriorly the frontonasal in *P. granulosus* is bordered by a subrectangular postnasal. In *P. abbotti* it is bordered laterally entirely by the large prefrontals. The large, subrhomboidal frontal unites equally with the prefrontals and frontoparietals. The frontoparietals are large, pentagonal plates that in this species meet on the median line, except where separated by the interposition of the pointed anterior extremity of the narrow interparietal. The latter is perforated by the pineal foramen near its posterior extremity as in some species of *Ophisaurus*. It is joined posteriorly by a narrow subquadrangular plate, probably the postinterparietal. The two last mentioned plates are bordered laterally by the six-sided parietals which are longer than wide.

Above the orbits there is an inner supraorbital series of five plates as in *Gerrhonotus*, with a smaller number, probably a row of three, in its external concavity. In specimen No. 1061, Yale Museum, two are present, as shown in Plate 21, Figure 5, but there may be one missing at the outer end of supraorbital 2. No. 1208, Kansas University, has one of this row at the junction of supraorbitals 2 and 3.

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[20] Bull. 58, U. S. National Museum, 1907, p. 194, figs. 176–178.

The parietals are bordered externally by a row of three pentagonal temporal plates of about equal size, best shown in No. 1061, Yale Museum. A fourth plate lies external to the two posterior temporal plates joining both subequally, as shown in Figure 83.

Posterior to the postinteroccipital the remaining part of the skull is covered over by transverse rows of quadrangular nuchal scutes like those on the body, except that the smooth area in the first few rows is very much reduced. The arrangement of these scutes is beautifully shown in No. 1208, Kansas University. (See fig. 76.)

The dorsal plates of the head have a tendency to fuse with one another and also with the underlying bones, especially in the parietofrontal region. In specimen No. 391, Walker Museum, fusion has gone so far as to practically obliterate all trace of their contacts.

Little evidence is left in the specimens now available of the complete arrangement of the plates of the lateral part of the skull, except in specimen No. 12861, Field Museum, which has a row of eight suborbitals on the left side beneath the eye (see pl. 22, fig. 2), and a lesser number are preserved in No. 1208, Kansas University. The largest ones are at either end and diminish in size toward the center of the row. There is a row of five labial scutes on the left side of the Kansas specimen. It is quite apparent that the scutes covering the lower jaw were not so closely attached to the underlying bones as in the skull, for in the considerable number of lower mandibles now before me, none has a single scute remaining attached.

Fig. 81.—Imbricating dorsal scutes of *Gerrhosaurus*. Ten times natural size. Corresponds to the imbrication of dorsal scutes in *Peltosaurus*. (After Schmidt)

That the lower side of the throat was entirely covered by osseous scutes is shown by several specimens, but more especially by No. 391, Walker Museum. (See pl. 22, fig. 3.)

This extinct form is probably subject to the same variation in its squamation as is found in the living lizards, but to determine the degree of variation will require many more and much better preserved specimens than are now available. While the arrangement of the scutes does not closely approach that of any of the extant lizards with which I am able to make comparisons, it in general bears out the angoid relationships shown by the skull and skeleton in having its closest general resemblance to the living *Ophisaurus*, and more especially to *Gerrhonotus*. (Compare figs. 83 and 84.) This is further indicated by the constantly present occipital or azygous shield back of the interparietal.

DERMAL SCUTES OF THE BODY

In two of the specimens studied (Nos. 391, Walker Museum, and 1208, Kansas University), a considerable number of the throat and neck scutes are retained *in situ* (see pl. 22, fig. 3, and text fig. 76). Other specimens have several scattered osseous scutes preserved. All are parallelogramic in shape, and their proximal or smooth concealed portions, overlapped by the preceding ones (see fig. 81) are from one-fourth to one-third their entire length. The granulation of their surfaces is fine and without distinct pattern. None with distinct carina. The scutes are arranged in straight, transverse rows, edge to edge, united by minute sutures. Some ventral scutes show beveled overlap on one edge. The ventral scutes can be distinguished from the dorsal by the smoothness of their surfaces near the posterior border, being almost devoid of sculpture. The borders of many of those forming the median ventral covering are curved from end to end, convex on one side and concave on the other, whereas all scutes which can be identified as dorsal in position have straight lateral borders.

Coprolite specimens (No. 10976) in the United States National Museum are of interest in containing many comminuted fragments of dermal scutes clearly recognizable as pertaining to the genus *Peltosaurus*, and probably to the present species. My colleague, Dr. J. W. Gidley, suggests that it may have been the large carnivorous *Hyænodon* that fed on this Oligocene lizard.

VERTEBRAE

Very few vertebrae of *Peltosaurus granulosus* are known, three broken dorsals with the type, an articulated series of 10 median dorsals belonging to specimen No. 1248, Carnegie Museum, and a few isolated vertebrae being all that is known of the vertebral column. The description to follow is based largely on the Carnegie specimen.

The 10 articulated dorsal vertebrae have a total length of about 45 millimeters, the centra are moderately depressed; the condylar end is oval and the greater part of the face of the ball faces upward and backward. The ball is set off by a very shallow annular groove on the ventral side. Viewed from below the median part of the centra is flattened, very slightly convex in transverse section. On either side, beginning posterior to the line of the parapophyses, there is a shallow open groove that defines the middle region as a wide band. (See pl. 11, fig. 7.) Above and external to this groove an obtuse longitudinal ridge forms the inferolateral angle of the centrum. Above this ridge is a shallow concavity occupying the side of the centrum. This depression is bounded above by the sharp and prominent ridge that connects the zygapophyses. The transverse process is vertical and narrow; it is sessile and not subdivided. The spinous process is of moderate height, with steeply receding anterior border that has its origin well forward on the neural arch; top but slightly enlarged transversely. The anterior border of this process is sharp; posterior border much thickened.

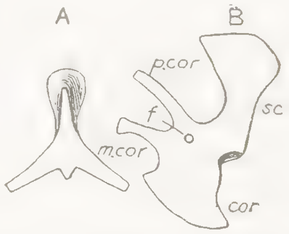

FIG. 82.—Pectoral girdle of *Peltosaurus granulosus* Cope. (No. 391, Walker Museum.) About one and one-half times natural size. A, interclavicle B, scapula and coracoid; *cor*, coracoid; *f*, coracoid foramen; *m. cor*, metacoracoid; *p. cor*, precoracoid; *sc*, scapula

An anterior caudal vertebra (No. 11392, Princeton Museum), showing stout chevron facets on the posterior half of the centrum, gives no indication that the chevron bone was coossified with them although it has been stated that such was the condition in this genus.

Cope describes a more anterior vertebra, evidently of the type as follows:

> A vertebra inclosed in matrix close to the skull is probably from the anterior part of the series. Its centrum is not so depressed as those already described, and it has a strong hypapophysial keel. Its ventral spine is rather elevated, and is grooved posteriorly.

Measurements of dorsal vertebra of type

	Mm.
Greatest length of centrum	6. 0
Transverse diameter of cup	4. 2
Greatest transverse diameter, anterior end	7. 0
Transverse diameter of ball	3. 0
Transverse diameter of neural arch beween zygapophyses	5. 0

PECTORAL GIRDLE

In specimen No. 391, Walker Museum (see pl. 22, fig. 3) is found the first evidence of the character of the pectoral girdle in *Peltosaurus.* The interclavicle, both scapulae, left coracoid, and a portion of the right, occupying somewhere near their relative position to one another as well as to the skull, are present in a fair state of preservation.

The interclavicle has the cruciform shape as in *Gerrhonotus*, which it closely resembles, except for the lack of the posterior stem. The anterior end is expanded for articulation with the clavicle, and on the ventral surface develops a longitudinal ridge that continues forward from the shaft for a short distance, thus dividing the articular surfaces for the clavicles. The transverse limbs of the interclavicle are slender and extend outward and backward. On the median line the osseous part of the interclavicle has a greatest length of 11 millimeters.

The scapula is relatively short, contracted above the heavy acetabular end but rapidly expanding into a wide plate with a truncated upper extremity. In length from the center of the acetabulum to the upper end of the blade, the right scapula measures 9.4 millimeters.

The left coracoid is the most completely preserved, lacking only a little of the anterior border. There are two notches as in most Anguidae. The coracoid foramen perforates the bone at a point about midway between the base of the most anterior notch and the glenoid border. The precoracoidal process is long and slender. The coracoid and scapula appear to be ankylosed, though a crack running from the glenoid fossa to the coracoid foramen may in part traverse the line of their sutural contact.

LIMB BONES

The only limb bone recognized in this large assemblage of *Peltosaurus* remains is a humerus lacking the distal end, belonging to specimen No. 1208, Kansas University Museum. As it is only worked out in partial relief, its full details are not to be seen. The proximal end is broadly expanded and its complete length is estimated to have been about 16 millimeters.

REFERRED SPECIMENS

The following specimens of this species have been identified in the assembled collections:

No. 990, American Museum of Natural History. Consists of a considerable portion of a right dentary bearing 13 teeth. From Oreodon zone, White River formation, Oligocene, Lewis Creek, Logan County, Colo. Collected by W. D. Matthew, 1898.

No. 271, Carnegie Museum. Consists of fragmentary parts of a dentary containing teeth. From "Lower Oreodon Beds," White River formation, Oligocene, Warbonnet Creek, Sioux County, Nebr. Collected by J. B. Hatcher, September, 1900.

No. 426, Carnegie Museum. Consists of portions of dentary and maxillary, both with teeth Oreodon zone, White River formation, Oligocene, Prairie Dog Creek, Hat Creek Basin, Sioux County, Nebr. Collected by O. A. Peterson, 1901.

No. 1038, Carnegie Museum. Consists of the anterior portion of the right dentary and a fragment of the left. Oreodon beds, White River formation, Oligocene, Sand Creek, Sioux County, Nebr. Collected by O. A. Peterson, June, 1902.

No. 1248, Carnegie Museum. Consists of parietal, frontal, both maxillae, greater portion of both rami. A block containing dermal scutes of both sides of the body, showing their arrangement *in situ* in relation to a series of dorsal vertebrae. Oreodon beds, Oligocene, Warbonnet Creek, Sioux County, Nebr. Collected by O. A. Peterson, June 25, 1904.

No. 1277, Kansas University Museum. Consists of a nearly perfect frontal. Oligocene, near Stone Ranch, northeastern Colorado. Collected by Handel T. Martin.

No. 1278, Kansas University Museum. Consists of portions of the right dentary. Oligocene, Cedar Creek, Colo. Collected by H. T. Martin, 1911.

No. 1280, Kansas University Museum. Consists of the nearly complete skull and lower jaws, cervicals, dermal scutes of the neck, and fragmentary parts of the pectoral arch. Oreodon beds, Oligocene, Hat Creek Basin, Sioux County, Nebr. Collected 1½ miles west of Anderson Ranch by E. Raymond Hall, 1922.

No. 10988, Princeton Museum. Consists of median portions of both rami with numerous fragments of skull dermal scutes and vertebrae. Lower Oreodon beds, Oligocene, Quinn Draw, Washington County, S. Dak. Collected by J. B. Hatcher, 1894.

No. 11392, Princeton Museum. Consists of dentary fragments, one cervical, one dorsal, and one caudal vertebrae, and one dorsal scute. Leptauchenia zone, White River formation, Oligocene. Battledraw Spring, Washington County, S. Dak. Collected by J. B. Hatcher, 1893.

No. 11393, Princeton Museum. Consists of a considerable portion of the skull and attached right ramus. Lower Oreodon beds, Oligocene, Hat Creek Basin, vicinity of Cottonwood Creek, Sioux County, Nebr. Collected by J. W. Gidley and H. F. Wells, 1895.

No. 12654, Princeton Museum. Consists of portions of the maxillary and ramus with numerous dermal scutes. From "lower zone of rusty nodules." Lower Oreodon beds, Oligocene, Corral Draw, Washington County, S. Dak. Collected by W. J. Sinclair, 1922.

No. 391, Walker Museum. Consists of skull and lower jaws lacking snout, numerous scutella of the throat and neck, and portions of the scapular arch nearly *in situ*. Lower Oreodon beds, Oligocene, Indian (?) Creek, Washington County, S. Dak. Collected by G. Baur and M. Farr in 1894 or 1895.

No. 1060, Yale Museum. Consists of the median portion of skull and left ramus. Oligocene, near Fort Mitchell, North Platte River, Nebr. Collected by A. S. Shelly, August 19, 1874.

No. 1061, Yale Museum. Consists of the greater portion of the skull, lacking the occipital segment, both rami (left complete), numerous skull and body osteoderms. Probably Titanotherium beds, Oligocene, Colorado.

No. 1065, Yale Museum. Consists of nearly complete right dentary containing teeth and anterior portion of left. Geological occurrence unrecorded but undoubtedly Oligocene. Near Captain Terry's ranch, North Platte River, Nebr. Collected by A. S. Shelly, August 23, 1874.

No. 1066, Yale Museum. Consists of portions of both dentaries. The history of this specimen is unknown.

No. 10603, United States National Museum. Consists of the occipital portion of a skull, two or more fragmentary vertebrae. Oligocene, Hat Creek Basin, Sioux County, Nebr. Collected by J. B. Hatcher, April 18, 1888.

No. 10604, United States National Museum. Consists of a slightly imperfect parietal bone. White River formation, Oligocene, Hat Creek Basin, Sioux County, Nebr. Collected by J. B. Hatcher, 1888.

No. 10605, United States National Museum. Consists of fragments of dentaries containing teeth. History same as preceding.

No. 10959, United States National Museum. Consists of portions of dentaries and one maxillary. History same as preceding.

No. 10960, United States National Museum. Consists of a large number of dermal scutes. History same as preceding.

No. 10976, United States National Museum. Consists of a considerable number of dermal scutes in coprolites. Oreodon zone, White River formation, Oligocene, Sheep Mountain, 5 miles south of Scenic, Wyo. Collected by J. B. Reeside, jr., 1924.

No. 1282, Kansas University, consists of the complete left dentary containing several teeth. Oligocene, Lewis Creek, Logan County, Colo. Collected by H. T. Martin, 1925.

No. 1283, Kansas University, consists of a median portion of a left ramus with four teeth. Oligocene, Logan County, Colo. Collected by H. T. Martin, 1925.

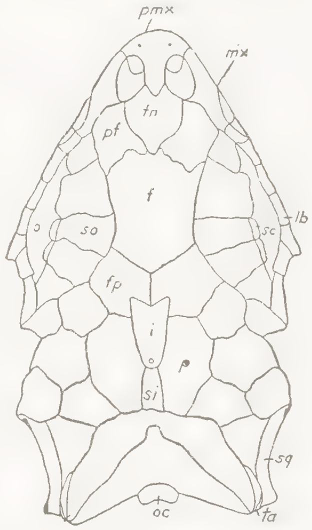

FIG. 83.—Skull of *Peltosaurus*] *abbotti* Gilmore. Type. (No. 12861, Field Museum.) About one and one-half times natural size. Viewed from above to show scutellation. Some of the lateral scutes and bones restored from specimens of *P. granulosus*. *f*, frontal scute; *fn*, frontonasal scute; *fp*, frontoparictal scutes; *i*, interparietal scute; *lb*, labial scutes; *mx*, maxillary; *o*, orbit; *oc*, occipital condyle; *p*, parietal scute; *pf*, prefrontal scute; *pmx*, premaxillary; *sc*, supracillary scutes; *si*, postinterparietal; *so*, supraorbital scutes; *sq*, squamosal; *ta*, tabulare

No. 1284, Kansas University, consists of a posterior portion of a right maxillary containing five teeth. Pawnee Creek Beds, Oligocene, Pawnee Creek, Logan County, Colo. Collected by H. T. Martin, 1925.

PELTOSAURUS ABBOTTI, new species

(Pl. 22, figs. 1, 2)

Type specimen.—Field Museum of Natural History, catalogue No. 12861. Consists of an imperfect skull and lower jaws. Collected by J. B. Abbott, 1905.

Type locality.—Cottonwood Creek, Washington County, S. Dak.

Horizon.—Leptauchenia zone (Protoceras beds), White River formation, Oligocene.

The specimen selected as the type of the present species is a fairly well preserved skull, as shown in Plate 22, Figures 1 and 2. The great breadth of the skull back of the orbits, the more regular convex profile of the upper anterior half, and the presence of a large, subtriangular frontonasal scute bordered on either side by a single large prefrontal scute appear to indicate its specific distinctness from *Peltosaurus granulosus*. The new species is named in honor of the collector, Mr. John B. Abbott.

The skull, posterior to the orbits, has a greatest transverse width of 36 millimeters, whereas a skull of *P. granulosus* (No. 1208 Kansas University Museum) of equal length measures only

28 millimeters. Other skulls now before me agree with the Kansas specimen in being one-fourth narrower in this transverse dimension.

In *P. granulosus* there is a tendency to exclude the frontonasal scute from contact with the frontal scute, and the former is in contact laterally and about equally with a prefrontal and postnasal, whereas in *P. abbotti* the frontonasal is bordered laterally by a single large prefrontal. Also the frontonasal is subtriangular in outline, while in *P. granulosus* it is trapezoidal.

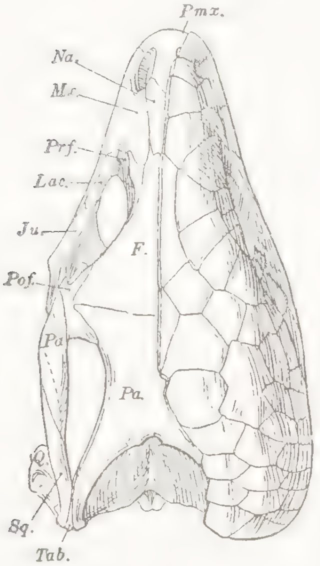

FIG. 84.—Skull of *Gerrhonotus scincicauda scincicauda* Skilton. (No. 595, Amer. Mus. Nat. Hist.) Twice natural size. Viewed from above. Secondary covering of bony scales shown on right side. Left side shows these removed. The general similarity to *Peltosaurus* is shown. *f*, frontal; *ju*, jugal; *lac*, lachrymal; *mx*, maxillary; *na*, nasal; *pa*, parietal; *pmx*, premaxillary; *po*, postorbital; *pof*, postfrontal; *prf*, prefrontal; *q*, quadrate; *sq*, squamosal; *tab*, tabulare. (After Camp)

The scutellation, stucture, and dentition of the skull, in so far as these can be compared, appear so similar to *P. granulosus* that there seems no necessity for entering further into these details.

The occurrence of this specimen in the Protoceras beds of the Leptauchenia zone of the White River formation marks it as being the youngest species of the genus.

Measurements

	Mm.
Greatest width of skull across center of jugals	36. 0
Least width of frontal at center	7. 0
Greatest width across center of anterior nares	12. 0
Length from posterior end of frontal to tip of premaxillary	27. 0
Greatest length from tip of premaxillary to posterior end of lateral parietal process	45. 0

PELTOSAURUS? PIGER, new species

(Pl. 26, figs. 4, 4a, 6, 6a)

Type specimen.—United States National Museum, catalogue No. 10687. Consists of the posterior portion of a right dentary containing six posterior teeth. Collected by O. A. Peterson, 1889.

Paratype.—United States National Museum, catalogue No. 10688. Greater portion of a right maxillary containing seven teeth. Collected by J. B. Hatcher, 1892.

Type locality.—"Peterson's quarry," Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

The present species is based on two specimens, of which I select the dentary No. 10687 as the type. On account of the resemblance of the teeth to those of *Peltosaurus*, it is provisionally referred to that genus.

The dentary contains an incomplete series of six perfectly preserved posterior teeth. They are stout, compressed longitudinally, with obtuse summits that are crossed longitudinally by a low ridge. The top of the crown is striated on both sides and at right angles to the ridge, giving it a puckered appearance. In worn teeth the ridge sometimes disappears along with most of the striations. The teeth are pleurodont. They diminish in size posteriorly, the last tooth being but little more than one-half the length of the sixth. The six teeth occupy a space of 4.6 millimeters. The largest tooth of the series, with a greatest length of 2.4 millimeters, extends only 0.6 of a millimeter above the external parapet of the dentary. All are hollow with a small opening at the base on the internal side.

The right maxillary (No. 10688) from the same horizon has the same style of tooth structure. In this bone there are seven complete teeth and evidence of three others, though the anterior end of the maxillary is missing. As in the type, six teeth occupy a space of 4.6 millimeters. The maxillary as preserved has a greatest length of 8 millimeters. Its principal features are well shown in Plate 26, Figures 4 and 4a.

The structure of the teeth, as mentioned above, is remarkably like that of *Peltosaurus*, but similar teeth are found in the very large *Glyptosaurus hillsi* from the Huerfano formation of Colorado. (See fig. 66.) From this evidence it is apparent that this particular type of tooth development is not entirely peculiar to *Peltosaurus*, and the generic assignment must therefore be regarded as only tentative.

A further similarity to *Peltosaurus* is seen in a longitudinal depression on the upper outside of the dentary paralleling the alveolar border, and a depression at the posterior end marks the overlap of the external process of the coronoid which terminates, as in the above genus, beneath the posterior tooth of the dentary series.

PELTOSAURUS (undetermined)

In the collection of fossil mammal materials from the Fort Union, No. 2, Paleocene, Sweetgrass County, Mont., in the United States National Museum, are three fragmentary specimens that may be safely referred to the genus *Peltosaurus*. These bear the catalogue numbers 10446, 10444, and 10811, and all were collected by A. C. Silberling in 1908. They have been directly compared with the teeth and dentaries of the type of the Oligocene species *P. granulosus* Cope with which they agree in size, and, in so far as they can be compared, no distinguishing differences were found; but since that species has not certainly been recognized below the Oligocene, I am loath to assign these specimens to it on such fragmentary evidence, and for the present shall regard them as specifically undeterminable.

In 1908 Lambe[21] described and figured a dermal scute, portion of a dentary, and part of a maxillary (catalogue Nos. 6234, 6235, 1230) from the Cypress Hills, Oligocene, which he referred to *Peltosaurus granulosus*. Through the courtesy of the officials of the Canadian Geological Survey I have had the opportunity to study this material. The portion of a dentary, when compared with the type, shows differences which suggest its specific distinctness. Although representing individuals of approximately the same size, the Canadian specimen has four teeth occupying a space of 5.3 millimeters, whereas five teeth occupy the same space in a similar part of the dentary of the type. The teeth have smooth crowns devoid of striations, though this may be due to wear. The maxillary also shows four teeth occupying nearly as much space as five teeth in the maxillary of the type, the crowns being also devoid of sculpture. The dermal scute was doubtfully referred to *P. granulosus* by Lambe because of the presence of a median carina and the more distinct granulation of the dorsal surface. Neither of these peculiarities would be against its assignment to the closely allied *Glyptosaurus*. An unidentified specimen, without catalogue number, in the Canadian collections from this same region and geological level, is a thickened dermal head scute having the dorsal surface thickly ornamented with rounded tubercles typical of the genus *Glyptosaurus*. It is of interest in the present connection in that the specimens referred by Lambe to *P. granulosus* can with equal propriety be referred to the genus *Glyptosaurus*. Regardless of their generic affinities, these Canadian specimens are certainly specifically distinct from *P. granulosus*. Because of their fragmentary character and the uncertainty of their generic affinities, I shall provisionally regard them as *Peltosaurus*. Both genera are found in the same Oligocene deposits in the United States, so there appears to be no reason why both *Glyptosaurus* and *Peltosaurus* should not occur in the Canadian Oliogocene.

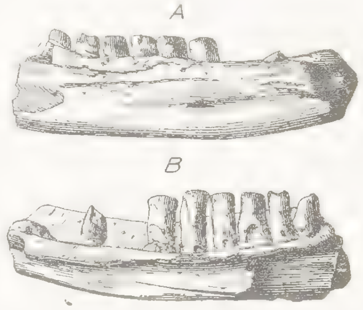

FIG. 85. Right dentary of *Peltosaurus ? piger* Gilmore. Type. (No. 10687, U. S. Nat. Mus.) About five times natural size. A, outer view; B, inner view

A specimen from the Torrejon formation, No. 5187, American Museum of Natural History, is provisionally identified as belonging to the genus *Peltosaurus*. In size and character of dentition it closely resembles *P. granulosus*, but more diagnostic materials are needed before an attempt can be made at a specific determination. The specimen, which consists of heavily incrusted jaw and skull fragments, was collected in Kimbetoh Wash, San Juan County, N. Mex., in 1913.

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[21] Contrib. to Canadian Pal., vol. 3, pt. 4, 1908, pp. 19, 20, pl. 1, figs. 23, 24, 25.

Genus MELANOSAURUS, new genus

Xestops, Camp, C., Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, pp. 328–329, figs. 101–103, 106, 107, 109–111.

Genotype.—*Melanosaurus maximus*, new species.

Characters.—Broad patches of teeth on pterygoids and palatines, few on vomer; quadrate with broad, thin, semicircular internal wing. Median cranial scutes longer than wide; interoccipital present; scutella of head and body covered with embossed tubercles. Postorbital distinct from postfrontal. Squamosal elongate.

The specimen upon which *Melanosaurus* is established was first referred by Camp to the genus *Xestops*. While clearly belonging to the Anguidae, this later study shows it to be generically distinct from *Xestops*.

The genus *Melanosaurus*, as shown by the close similarity in the arrangement and character of the scutellation of both head and body, and the many resemblances in skull structure, apparently has its nearest affinities with the genus *Peltosaurus*. In its scutellation, dentition, and general skull structure, *Melanosaurus* is typically anguid, and such features as the quadrate with broad, thin, semicircular internal wing, postorbital distinct from postfrontal, elongate squamosal, and distinct paroccipital, are, for the present at least, regarded as generic distinctions and not indications of family differences. Certainly the observed differences between *Peltosaurus* and *Melanosaurus* are not greater than those found between *Gerrhonotus* and *Ophisaurus*, and systematists are now quite agreed that they pertain to the same family.

At this time, *Melanosaurus* is known by the single species *M. maximus*, from the Wasatch formation, Big Horn County, Wyo.

In the Princeton Museum collection is a specimen (No. 11494) from the Phosphorites near Caylus, France, identified as *Lacerta lamandini* Filhol. It consists of a nearly perfect right maxillary bearing a full complement of teeth, and a left dentary also carrying teeth. The dentition closely resembles the blunt, striated crowns with low, longitudinal ridge found in some species of *Glyptosaurus*, and especially those of *Melanosaurus maximus*. Furthermore, the upper facial portion of the maxillary is covered with fused tuberculated scutes as in *M. maximus*. These close resemblances in dentition and ornamentation allow the suggestion that perhaps after all this lizard belongs to the Anguidae instead of the Lacertidae.

MELANOSAURUS MAXIMUS, new species

(Pl. 15, fig. 2; pls. 23, 24)

Type specimen.—American Museum of Natural History, catalogue No. 5168. Consists of the greater portion of a crushed skull and lower jaws; parts of two vertebrae; numerous dermal scutes; and many fragments. Collected by William Stein, September 28, 1912.

Type locality.—Five miles southeast of the mouth of Pat O'Hara Creek, Clark's Fork Basin, Big Horn County, Wyo.

Horizon.—"Above red-banded beds," Wasatch formation, Lower Eocene.

Paratype.—American Museum of Natural History, catalogue No. 5175. Consists of parietal, frontal, occipital region, parts of both maxillaries containing teeth, premaxillary with teeth, left jugal, parts of both rami, portion of quadrate, parts of limb bones, 10 vertebrae, numerous dermal scutes, and unidentified fragments. Collected by Walter Granger, July 5, 1911.

Locality.—South side of Ten Mile Creek, Big Horn Basin, Big Horn County, Wyo.

Horizon.—Wasatch formation, Lower Eocene.

The specimen selected as the type of this new species has the skull flattened out by vertical pressure, and consequently much of its structure is obscured. It is, however, beautifully supplemented by a disarticulated skull of slightly larger dimensions from the same region and geological formation, which I have designated the paratype.

The type specimen was the basis for the restoration of the skull by Camp[22] (see fig. 87), which he referred to the genus *Xestops*. Comparison with the type species of *Xestops* shows at once that its affinities do not lie in that genus. The frontals, with excavated borders between the orbits, and dermal scutes meeting laterally by suture, exclude it from *Xestops* in which the frontals have the lateral borders between the orbits (see fig. 96) nearly parallel, and the dermal scutes uniting laterally by beveled overlap. In both of these, and in several other respects to be mentioned later, the type specimen more nearly approaches *Peltosaurus granulosus*. The parietal and frontal bones have their superior surfaces covered with the tubercular ornamentation as in *Peltosaurus*. The osteoderms on these bones are thoroughly coossified with them, as well as with each other. With the exception of the interparietal and interoccipital, so firmly coalesced have most of these scutes become that all trace of their union has been obliterated. These two scutes are elongate anteroposteriorly and narrow transversely, the interparietal as in *P. granulosus*, being perforated near its posterior extremity by a small pineal foramen. (See fig. 88.) The parietal in the type is 23.1 millimeters long at the center and has an estimated width of about 20 millimeters. These same measurements of the paratype are: Length, 31.5 millimeters; width, 28 millimeters. The frontoparietal suture is straight. Frontal as in *P. granulosus*, except for its much larger size. Olfactory ridges on ventral surface robust in the paratype and strongly incurved but not meeting below olfactory lobe. Length, 29 millimeters; width between the orbits, 14 millimeters; width at posterior end, 23.4 millimeters. The frontal of the paratype has a length of 35 millimeters; width between orbits, 20 millimeters; width at posterior end, 30 millimeters. The largest available frontal of *P. granulosus* measures only 17 millimeters in this diameter.

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[22] Bull. Amer. Mus. Nat. Hist., vol. 48, 1923, figs. 106, 107.

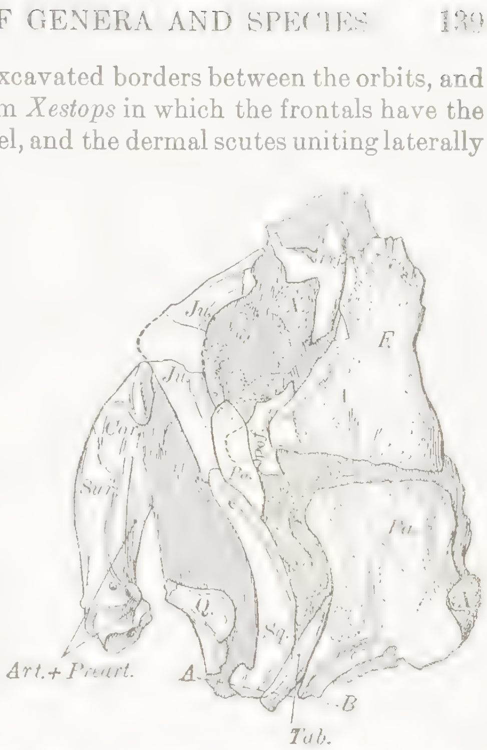

FIG. 86.—Skull of *Melanosaurus maximus* Gilmore. Type. (No. 5168, Amer. Mus. Nat. Hist.) Natural size. Dorsal view. The disarticulated bones lie nearly in position showing the correct relation of the frontals. *art.+preart*, articular and prearticular; *cor*, coronoid; *f*, frontal; *ju*, jugal; *pa*, parietal; *po*, postorbital; *pof*, postfrontal; *prf*, prefrontal; *q*, quadrate; *sq*, squamosal; *sur*, surangular; *tab*, tabulare; *x*, dermal scutes. A–B section, see fig. 90. (After Camp)

Postfrontal slightly displaced, as shown on the left side. (See *pof*. fig. 86.) It is a subcrescentic bone that unites about equally with the parietal and frontal at their junction. It does not meet the prefrontal above the orbit. The reduced postorbital appears as a distinct element on the left side (see *po*, fig. 86). This bone is present in *Peltosaurus granulosus* (specimen No. 391, Walker Museum) but is firmly coossified with the post-frontal. In *Melanosaurus maximus* it is shown to be an elongate structure with a tapering posterior extremity that laps along the inner anterior side of the squamosal. The anterior end is bluntly pointed and articulated entirely with the postfrontal and jugal, with a small participation in the boundary of the orbit as in *Gerrhonotus*. The presence of the tabulare is clearly and unmistakably shown as first pointed out by

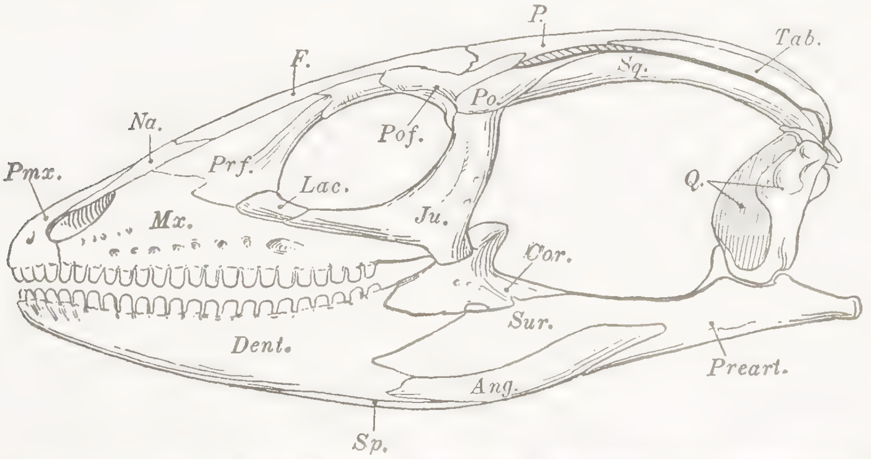

FIG. 87.—Skull of *Melanosaurus maximus* Gilmore, reconstructed. Based chiefly on the type specimen (No. 5168, Amer. Mus. Nat. Hist.) About 1.2 times natural size. Outer view. *ang*, angular; *cor*, coronoid; *dent*, dentary; *f*, frontal; *ju*, jugal; *lac*, lachrymal; *mx*, maxillary; *na*, nasal; *p*, parietal; *pmx*, premaxillary; *po*, postorbital; *pof*, postfrontal; *preart*, prearticular; *prf*, prefrontal; *q*, quadrate; *sp*, splenial; *sq*, squamosal; *sur*, surangular; *tab*, tabulare. (Modified from Camp)

Camp [23] (see *tab*, fig. 86). A tabulare of equal extent is present in *P. granulosus*, as indicated by a groove on the side of the parietal in specimen No. 11373, Princeton Museum. The synonymy of this element is very confusing, as pointed out by the above authority. "By Zittel, Baur, and Watson it is regarded as the true squamosal; by Hoffman, Cope and Siebenrock it is called supratemporal, by Sollas prosquamosal and by Williston and Broom tabulare." The position of the element is constant enough in lizards to enable one to be fairly certain of its identity, so that the true homology of the bone need not especially concern us at this time, and I shall follow Williston, Broom, and Camp in calling it the tabulare. Only the anterior end of the left tabulare is present but it is closely applied to the side of the posterior parietal process (see pl. 23, fig. 1); the body of the bone was wedged in between the squamosal and the parietal process posteriorly, the three forming the chief support for the rather loosely attached quadrate, as in *Glyptosaurus montanus* and the Anguidae in general. After a study of the articulated tabulare in the last named species, I am inclined to believe that, while the tabulare is long, its dorsal exposure in the reconstructed skull (fig. 88) is exaggerated.

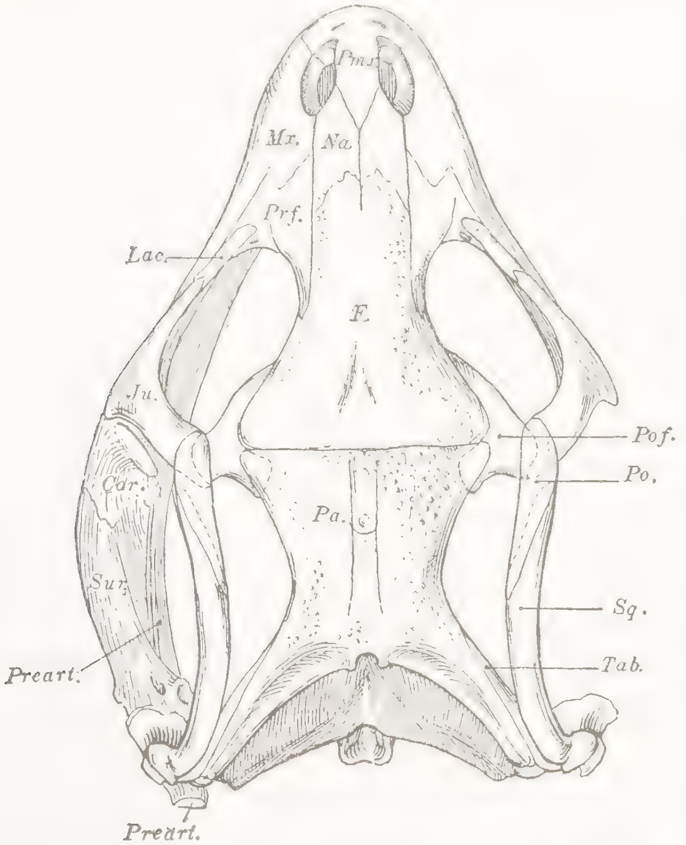

FIG. 88.—Skull of *Melanosaurus maximus* Gilmore, reconstructed. Based chiefly on the type specimen (No. 5168, Amer. Mus. Nat. Hist.). Viewed from above. About 1.2 times natural size. *cor*, coronoid; *f*, frontal; *ju*, jugal; *lac*, lachrymal, *mx*, maxillary; *na*, nasal; *pa*, parietal; *pmx*, premaxillary; *po*, postorbital; *pof*, postfrontal; *preart*, prearticular; *prf*, prefrontal; *sq*, squamosal; *sur*, surangular; *tab*, tabulare. (After Camp)

The squamosal is especially long and appears to extend forward nearly to the jugal, as it apparently does in *Peltosaurus granulosus*.

The prefrontal, so far as it can be observed, appears more massive than in the smaller *Peltosaurus*. In the restored skull (fig. 87), Camp evidently used the prefrontal of *Glyptosaurus*, No. 5113, American Museum of Natural History, as a guide.

The jugal, which is best shown in the paratype (see pl. 4, figs. 3–4) is massive in a lateral view but in cross section is found to be much thinned toward the edges, becoming thickened toward the orbital border. It is rectangular in outline, with a spurlike projection on the posterior border at the angle. It closely resembles the corresponding bone in *P. granulosus* except for its much larger size. In cross section it is everywhere triangular.

The lachrymal can not be certainly recognized. The proximal half of the left quadrate is present, as shown on Plate 24, Figure 1. Its chief peculiarity is in having a broad, thin, semicircular internal wing. Camp [24] points out that this wing "is represented in *Heloderma* by a slight ridge and is absent in *Gerrhonotus*." It is also absent in *Ophisaurus*. *Sauromalus*, however, has a somewhat similar internal extension of the quadrate, and in *Iguana* it reaches an enormous development, though in *Crotaphytus* it is represented by a narrow ridge; in others members of the Iguanidae, as *Cnemidophorus* and *Phrynosoma*, this ridge is altogether wanting. Fortunately one of the available specimens of *Peltosaurus granulosus* has the quadrate perfectly preserved, so it is known that this winglike expansion is not present in that genus, and its presence in *Melanosaurus* forms an important distinction between it and the closely allied *Peltosaurus*.

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[23] Op. cit., p. 328.

[24] Op. cit., p. 480.

The maxillae of the type specimen are too fragmentary for description but those of the paratype show the facial plate to be large and with a longitudinally concave external surface. They are perforated by the usual foramina. The upper posterior external surfaces are ornamented with the same ornamentation as found on the parietal and frontals. The osteoderms are coossified with the underlying bone and with one another to such an extent that the individual scutes can no longer be observed, a condition also noted in *P. granulosus.*

The premaxillary, except for its much larger size, closely resembles the corresponding bone in *P. granulosus.* Viewed from the front, the alveolar border is broadly curved from side to side. It carries eight subequal teeth in the complete series, as in *P. granulosus.* The spine is relatively wider at the base than in the above-mentioned species, and there is a small foramen at the base of the spine on each side. The alveolar border in the premaxillary of specimen No. 5175, American Museum of Natural History, measures 14.5 millimeters in transverse diameter.

In the paratype the articulated occipital region gives some information as to this portion of the skull. Viewed from behind, the occipital condyle is reniform in outline, but its tripartite composition is not indicated. The supraoccipital is firmly sutured to the underlying elements. It has a sharp median ridge running upward from the border of the foramen magnum to which it apparently contributes. The upper extremity of the supraoccipital appears to have been loosely articulated with the parietal as in *Ophisaurus.*

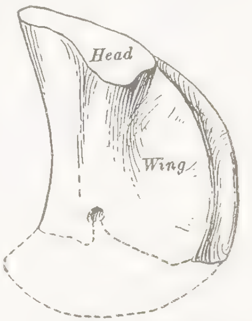

FIG. 89.—Quadrate of *Melanosaurus maximus* Gilmore. Type. (No. 5168, Amer. Mus. Nat. Hist.) Three times natural size. Posterointernal view. (After Camp)

In Figure 90 is shown the paroccipital bone which is separate from the exoccipital, with its posterior extremity lying beneath the tabulare-parietal suture. There is a dorsal groove on the exoccipital for the reception of the paroccipital. Camp first recognized this bone as a separate element in this specimen, and it is his drawing (fig. 90) that illustrates its relationships to the surrounding elements. Leydig has recognized a similar distinct element in *Lacerta agilis,* but so far as I have been able to learn this bone has not before been found as a separate element in any of the Anguidae.

The palatal side of the type skull, though badly crushed, nevertheless displays some of the important features of the palate in this species. Reference is made especially to the presence of pterygoid, palatine, and vomerine teeth. The pterygoid and palatines bear extensive patches as is clearly shown in Plate 24, Figure 1. Those on the vomer are reduced to a narrow band, and the individual teeth do not stand out with the same distinctness as on the other bones of the palate. The pterygoid and palatine teeth are minute, thickly placed, many with sharp points directed backward, and all are placed without definite arrangement. The patch on the pterygoid is widest behind and tapers to a blunt point toward the front. This patch has a greatest length anteroposteriorly of 13 millimeters, a greatest width of 6 millimeters. The patch on the palatine is not so extensive and is 9 millimeters long and measures 4 millimeters at the widest part. The vomerine teeth are arranged in a narrow band and are relatively few in number.

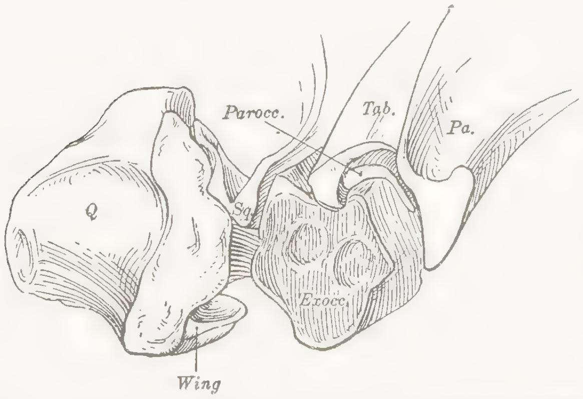

FIG. 90.—Section of quadratoparietal region of *Melanosaurus maximus* Gilmore. Type. (No. 5168, Amer. Mus. Nat. Hist.) Section through line A–B, fig. 86. *exocc,* exoccipital; *pa,* parietal; *parocc,* paroccipital; *q,* quadrate; *sq,* squamosal; *tab,* tabulare; *wing,* winglike extension of quadrate. (After Camp)

Among living Sauria, *Ophisaurus* is said to have the most dentigerous palate of all lizards, and is also the only extant form known to have vomerine teeth. Their retention in this genus would rather indicate an ancestry in which these teeth were very much more numerous.

The other features of the palate are so obscure as to render their study of but little significance.

Lower jaw.—In the type the greater portions of both rami are preserved, but both lack their anterior extremities. (See pl. 23, fig. 2, and pl. 24, fig. 2.) The jaws are robust, with a strong bending in of their posterior extremities, beginning back of the coronoid. The coronoid has only a short, blunt anterior extension on the outer face, with long inner process that extends forward and downward, terminating as a sharp point opposite the second tooth from the back of the dentary series. The angular shows broadly in a lateral view, and strongly overlaps the underlying surangular. The dentary-surangular suture lies directly below the forward line of the coronoid as in *Glyptosaurus*. The surangular, articular, and prearticular are all thoroughly coossified. Splenial extensive, narrowing rapidly toward the front, where it underlies the dentary and completely covers Meckel's groove.

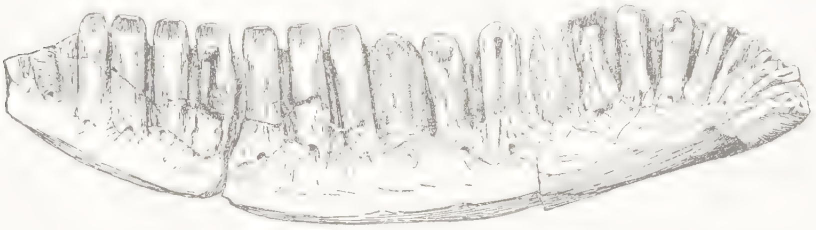

FIG. 91.—Left dentary of *Melanosaurus maximus* Gilmore. Paratype. (No. 5175, Amer. Mus. Nat. Hist.) Two and one-half times natural size. Inner view. (After Camp)

The teeth.—The dental formula of *Melanosaurus maximus* appears to be very similar to that of *Peltosaurus*. The premaxillary bears 8 teeth, the maxillary 16. The left dentary, as figured by Camp (fig. 91) shows evidence of 21 teeth, the same as found in *Peltosaurus granulosus*. The teeth are pleurodont, robust, and relatively short, extending but little above the parapet of the jaw. The shafts are semisolid. The apices of the teeth are bluntly chisel-shaped (see fig. 92), being more obtuse and rounded than in *P. granulosus*. They also differ from that species in having a low, weakly defined longitudinal cutting edge which bends angularly inward at the center instead of presenting a straight cutting edge running in the direction of the long axis of the jaw. Under the glass the surfaces of the crowns are seen to be delicately parallel wrinkled, usually running at right angles to the cutting edge. On the inner side the basal portions of the teeth are but little expanded, with surfaces coarsely striated much as in *Varanus* and *Saniwa*. The teeth are closely placed in the series. In a space of 10 millimeters in the dentary of the type there are 5 teeth. In the maxillary of the paratype (No. 5175) there are 4½ teeth in a 10-millimeter space. These proportions would indicate an animal twice the dimensions of *P. granulosus*, which has 8 teeth in a similar space.

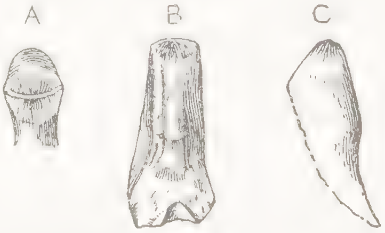

FIG. 92.—Posterior tooth of the dentary of *Melanosaurus maximus* Gilmore. Type. (No. 5168, Amer. Mus. Nat. Hist.) About four times natural size. A, top; B, inner; C, anterior views

In the character of the sculpturing of the crown the teeth of *Melanosaurus maximus* rather closely resemble those of *Glyptosaurus hillsi*. (Compare figs. 66 and 92.)

In *Gerrhonotus* the small replacement teeth (see fig. 93, A) do not enter the bases of the old shafts but lie outside them as in most Anguimorpha. Similar features are seen in the maxillary of the paratype. (See *o*, fig. 93, B.)

The upper and lower teeth seem to be indistinguishable. The reduction in size and the highly inclined position of the anterior teeth at the symphysis are clearly shown in Figure 91. These same conditions are found in *Glyptosaurus* and in *Gerrhonotus*, though the inclination is not so acute in the latter genus.

Vertebrae.—While there are parts of several dorsal vertebrae present with the paratype, their poor preservation renders a careful comparison with the dorsals of *Peltosaurus granulosus* quite impossible. In so far as such comparison is possible, they show no characters which might serve to distinguish them except their larger size.

The caudal region is represented in the paratype by a single anterior caudal vertebra which shows the chevrons to have had a posterior central attachment as in *Glyptosaurus tuberculatus* (Douglass). (See fig. 3, pl. 23.) There is evidence sufficient to suggest that the chevrons were probably fused with the vertebra as they are in the living *Ophisaurus* and *Anguis*. In *Glyptosaurus*, however, as represented by a specimen of the above species, they remained distinct and had a pediculate articulation. In this connection attention should be called to a somewhat similar chevron articulation, though more central in position, to be observed in the type caudals of *Xestops lentus* (Marsh).

The ball is oval, with articular face looking upward and backward. The lower rim of the cup in this anterior caudal is flattened, and viewed from below is concavely excavated transversely. Camp calls attention to the transverse process in the paratype as arising from the whole length of the centrum as in *Gerrhonotus*. (See fig. 95.)

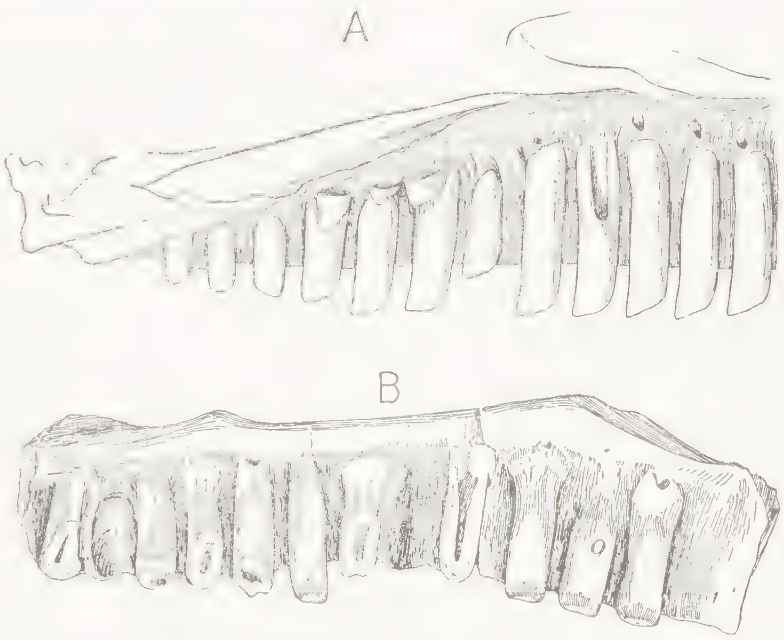

FIG. 93.—Maxillary teeth. A, *Gerrhonotus scincicauda scincicauda* (Skilton.) (No. 595, Amer. Mus. Nat. Hist.) Six times natural size. B, *Melanosaurus maximus* Gilmore. Paratype. (No. 5175, Amer. Mus. Nat. Hist.) Three times natural size. *o*, an old shaft which indicates by erosion at the base that a replacement bud has occupied a position comparable with that seen in *Gerrhonotus*. (After Camp)

Dermal scutes.—There are numerous rectangular dermal scutes preserved with both the type and paratype. With the exception of the narrow, smooth band at the anterior end, these have their superior surfaces thickly covered with small, rounded tubercles that in most instances form no definite pattern. In specimens numbered 1616 and 6167, American Museum of Natural History, referred to this species, the articulated scutes are preserved but little disturbed, many of them showing the tubercles to be arranged in two or more parallel rows around the periphery of the scutes, in this respect resembling the scutal ornamentation found in some species of *Glyptosaurus*. This distinct style of ornamentation on the scutes of the head and body will serve to at once distinguish these portions of *M. maximus* from the less distinct granular pattern found in *P. granulosus*. The scutes may also be distinguished from those of *Xestops vagans* by the entire absence of sharp-edged carina and the more perpendicular lateral articular borders which unite by suture.

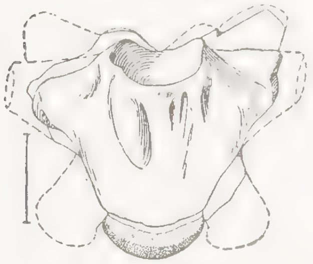

FIG. 94.— Mid-dorsal vertebra of *Melanosaurus maximus* Gilmore. Paratype. (No. 5175, Amer. Mus. Nat. Hist.) About twice natural size. Viewed from below. (After Camp)

A block of scutes of No. 6167, American Museum of Natural History (see pl. 27, fig. 7), is of interest as exhibiting much of the arrangement of the scutes covering the throat and neck. The posterior ends of the rami protruding from the matrix at one end and the presence of a coracoid at the other, apparently identifies it as being of the neck. The dorsal side is identified by the protrusion through the scutes of a row of neural spines of four or more articulated vertebrae. That this is the upper or dorsal surface is further substantiated by the better-defined ornamentation of the scutes as compared with those of the opposite side. The scutes are shown to overlap shinglewise, and apparently in rows encircling the neck. Longitudinally the scutes do not appear to have formed continuous rows but were offset on one another so as to break joints. This feature is more clearly shown in a second specimen, No. 1616, American Museum of Natural History.

REFERRED SPECIMENS

As indicated above, the following specimens, in addition to the types, are referred to this species:

No. 6167, American Museum of Natural History. Consists of several blocks of body scutes more or less articulated. Inside these blocks is a portion of a dentary, coracoid, and several vertebrae. Gray Bull, Wasatch formation, lower Eocene, South Elk Creek, Big Horn Basin, Wyoming. Collected by American Museum expedition of 1916.

No. 1616, American Museum of Natural History. Consists of fragmentary part of skull and lower jaw associated with a considerable block of dermal scutes nearly *in situ*. Wasatch formation, lower Eocene, 3 miles southeast of mouth of Pat O'Hara Creek, Clark's Fork Basin, Big Horn County, Wyoming. Collected by Walter Granger, 1912.

Genus XESTOPS Cope

Oreosaurus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 307.
Xestops Cope, E. D., New Vertebrata from Tertiary of Colorado, 1873, p. 19 (to replace *Oreosaurus*, preoccupied).

Genotype.—Xestops vagans (Marsh).

Characters.—Frontals distinct; sides between orbits nearly parallel; frontoparietal scutes not meeting on median line; dermal scutes of body asymmetrically carinate, meeting laterally by beveled edges. Pterygoid teeth extensive. Ornamentation of scutes granular.

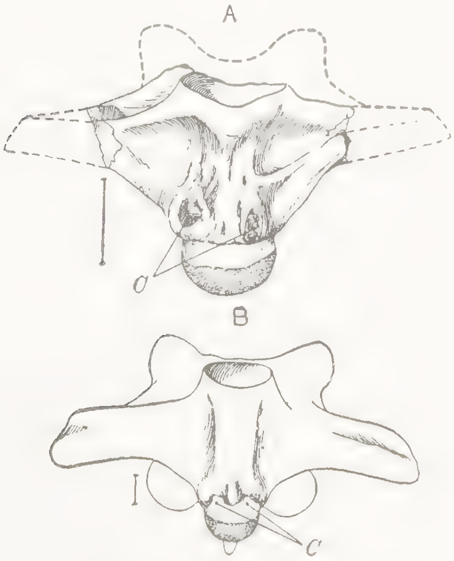

FIG. 95.—Comparative views of first caudal vertebra. About six and one-half times natural size. A, *Melanosaurus maximus* Gilmore. Paratype. (No. 5175, Amer. Mus. Nat. Hist.); B, *Gerrhonotus scincicauda scincicauda* (Skilton). (No. 595, Amer. Mus. Nat. Hist.); C shows attachment for chevrons. (After Camp)

In October, 1872, Marsh proposed the genus *Oreosaurus*, the species *O. vagans* being selected as the genotype. A year later Cope found that *Oreosaurus* was preoccupied and proposed the name *Xestops* to replace it. Neither Marsh nor Cope ever indicated the family affinities of this genus, but in 1902 Hay included it in the Anguidae, an assignment which further study appears to substantiate.

The presence of rectangular body osteoderms, pterygoid teeth, scutellation of the frontals, and obtusely crowned teeth with striated summits indistinguishable from those of certain species of both *Peltosaurus* and *Glyptosaurus*, are all features indicative of anguid relationships. It is only through the discovery of more adequate specimens, however, that we may hope to clear up all uncertainty regarding the family affinities of this genus.

Marsh subsequently described four other species, *X. gracilis*, *X. minutus*, *X. microdus*, and *X. lentus*, all founded on exceedingly fragmentary specimens. No good reason exists, except that of expediency, for the retention of these species in the present genus. A comparison of the type specimens, fragmentary though they are, indicates that in all probability two or more genera are represented, but rather than base new names on such inadequate material, I propose to retain them in the present genus. The discovery of better-preserved specimens only will disclose their true affinities. All of the known species are from the Bridger formation, Middle Eocene, of Wyoming, except *X. pawneensis* which is from the Oligocene of Colorado.

Key to species

Typically of moderate size; jaws heavy; posterior and median teeth with obtuse striated crowns	*X. vagans.*
Typically small; jaws slender; anterior teeth with sharp, compressed crowns without striae	*X. gracilis.*
Typically very small; jaws slender, teeth simple, sharply pointed, smooth. Upper teeth with lateral denticle	*X. minutus.*
Typically very small; jaws moderately heavy; teeth nearly round, marked with irregular striae	*X. microdus.*
Founded on caudal vertebrae having chevron attachments on raised ridges on posterior half	*X. lentus.*
Typically small, eight and one half maxillary teeth occupy space of 5 millimeters	*X. pawneensis.*

XESTOPS VAGANS (Marsh)

(Pl. 19, figs. 3 to 11)

Oreosaurus vagans Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 303.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 48.

Xestops vagans (Marsh) Cope, E. D., Synop. new Vertebrata from Tert. of Colorado, Washington, October, 1873, p. 19 (generic reference).—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.

Type specimen.—Yale University Museum, catalogue No. 541. Consists of the frontals, portions of right and left dentaries containing teeth, basal portion of right coronoid, fragment of pterygoid containing teeth, numerous dermal scutes, and unidentified fragments of skull and jaws. Collected by O. C. Marsh, September 7, 1871.

Type locality.—Grizzly Buttes, Uinta County, Wyoming.

Horizon.—Horizon B, Bridger formation, Middle Eocene.

Original description.—This genus may be distinguished from *Glyptosaurus*, apparently its nearest ally, by the frontal bones, which are proportionally much narrower at their posterior margin and broader between the orbits. The superior surface of these bones is, moreover, rough and granular, which would indicate that they were not covered with osseous scutes. The body was thus protected, but the dermal plates preserved, even those evidently from the dorsal region, were united together by beveled edges. The teeth were pleurodont. The pterygoid bones supported minute tubercular teeth, resembling those of *Glyptosaurus*.

In the species here described the teeth are rodlike, with small bases and obtuse striated summits, which are crowned by a low longitudinal ridge. The frontals are thick and loosely united by suture. Between the orbits their sides are nearly parallel. Their upper surface is evenly marked by small irregular tubercles. The dermal scutes preserved have a similar pattern, and some of them are carinate. The species was about 3 feet in length.

Measurements

	Mm.
Space occupied by eight teeth near middle of lower jaw	11. 2
Space occupied by four anterior teeth of upper jaw	5. 0
Width of band of small teeth on pterygoid	4. 6
Width of frontals at posterior margin	13. 0
Width between orbits	11. 0

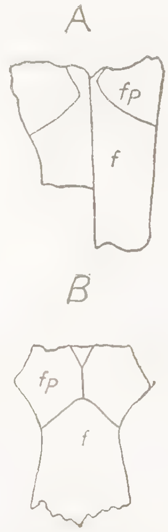

FIG. 96.—Comparative view of frontals of *Xestops* and *Peltosaurus* and their scutellation. About one and one-half times natural size. A, *Xestops vagans* (Marsh). Type. (No. 541, Yale University.) B, *Peltosaurus granulosus* Cope. (No. 11393, Princeton University.) *f*, frontal scutes; *fp*, frontoparietal scutes

The granular surfaces of the frontals, pterygoids bearing minute teeth, pleurodont dentition, teeth with swollen obtuse summits, crowned with a low longitudinal ridge having parallel wrinklings at right angles to the cutting edge; and the presence of numerous rectangular dermal scutes are a combination of characters which indicate the affinities of this species to be with the family Anguidae. Its distinctness from *Peltosaurus*, with which it appears to be most closely related, is indicated by its distinct frontals with nearly parallel borders between the orbits, and dermal scutes with strongly beveled edges with sharp-edged carina. The frontoparietal scutes closely approach but do not meet on the median line, as shown in Plate 19, Figure 3. Marsh was mistaken in regarding the frontals to be devoid of osseous scutes. That the granular surface described by him is that of the overlying scutes is clearly shown by comparison with skulls of *Peltosaurus granulosus* now before me, some of which have the scutes firmly coossified with the underlying skull bones, while in others they are loose or only partialy coossified.

The body, as Marsh has pointed out, was protected by osseous, rectangular scutes that were probably arranged in successive rows as in the other genera of the Anguidae, since they have the same smooth anterior ends for the overlap of the preceding row. The lateral edges, however, are strongly beveled, one side from above downward, the other from below upward, indicating an overlap along the sides instead of abutting as they do in both *Peltosaurus* and *Glyptosaurus*. The upper surfaces of the scutes are granular in pattern and many of them have a low asymmetrical carina as shown in Plate 19, Figures 4 to 9. The teeth are not accurately described by calling them "rodlike" for their upper extremities, while not expanded, are bluntly wedge-shaped with a strong bevel of the crown to the external side which gives their apices an especial robustness; also the shafts are somewhat flattened on the anterior and posterior sides. As a whole they are practically indistinguishable from the teeth of *Peltosaurus*. The coronoid is not extensively developed on the external side of the ramus, hardly reaching the line of the most posterior tooth, but on the inside it extends forward in advance of that tooth, as in *Melanosaurus maximus*.

A fragment of the pterygoid shows an oval patch of small tubercular teeth. This patch has a complete width of 4.6 millimeters and a complete length of 8 millimeters. In the large area covered by the pterygoid teeth, *Xestops vagans* resembles *Melanosaurus maximus*, a feature that would apparently distinguish both of these species from *Peltosaurus granulosus*, which has these teeth restricted to a narrow row.

?XESTOPS GRACILIS (Marsh)

(Pl. 2, figs. 5 to 10)

Oreosaurus gracilis Marsh, O. C., Amer. Journ. Sci., 3d ser., vol 4, 1872, p. 307.

Xestops gracilis (Marsh) Cope, E. D., Synop. New Vertebrata from Tert. of Colorado, Washington, October, 1873, p. 19 (generic reference).—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Nopcsa, F. B., Beitr. Pal und Geol. Oester.-Ung., vol. 21, 1908, p. 48.

Type specimen.—Yale University Museum, catalogue No. 1055. Consists of the anterior half of a right dentary containing two nearly perfect teeth and the bases of several others. Collected by O. C. Marsh, September 16, 1871.

Type locality.—Henry's Fork, Uinta County, Wyoming.

Horizon.—Horizon C or higher, Bridger formation, Middle Eocene.

Original description.—A somewhat smaller lizard, which may for the present be likewise referred to the genus *Oreosaurus*, is represented by several specimens, nearly all pertaining to different individuals. The most characteristic of these is the greater portion of a right lower jaw in perfect preservation. The teeth in this specimen are numerous and close together. They are conical in form, with small bases, and smooth sharp summits, lightly compressed. The jaws were slender and but loosely attached to each other by a small symphysis. The groove for Meckel's cartilage is narrow and very short. The specimens preserved indicate a reptile about 2 feet in length.

Measurements

	Mm.
Space occupied by the 14 anterior teeth of lower jaw	10. 2
Depth of jaw below fourteenth tooth	3. 5
Thickness of jaw at this point	2. 4
Length of symphysis	2. 0

In the above description Marsh mentions "several specimens, nearly all pertaining to different individuals." In the vial containing the dentary which he clearly regarded as the type, there were five dermal scutes, but it is not certain that these belong to the type specimen, although I provisionally regard them as such. (See pl. 2, figs. 5 to 9.) The uncertainty of their association apparently existed in Professor Marsh's mind from the fact that none of them were mentioned in his original description of the species.

A comparison of the dentary of *Xestops gracilis* with that of the type of *X. vagans* shows but little in common. The simple, smooth, pointed teeth and extremely small and slender size of the whole dentary certainly do not suggest close affinities with the thick, wedge-shaped teeth, with low median longitudinal ridge of *X. vagans*, though it is recognized that teeth showing similar differences are sometimes found in the same jaw.

Meckel's groove is closed except where it emerges at the symphysial end. The bases of the teeth are closely pressed together (see pl. 2, fig. 10), being much compressed anteroposteriorly. They appear to replace alternately, this observation being based on the fact that every other tooth, commencing with the most posterior, is excavated at the root. This feature appears to indicate relationship to the Anguimorpha, all of which, except the Zonuridae, have the succession of teeth alternate.

A posterior portion of a right dentary (No. 1094, Yale Museum) containing two teeth is tentatively referred to this species. The width and shape of the dentary, the slightly compressed teeth with excavated bases, and the method of their implantation are all in accord with the type specimen. The crowns of the teeth, however, are weakly tricuspid as contrasted with the simple pointed teeth from the anterior portion of the dentary series. This division of the crown is more clearly apparent from an internal than from the external view, due to vertical depressions which distinctly set off the small lateral denticles from the main median cusp on the inner side. The apex of the median denticle is bluntly rounded fore and aft and appears to develop an outer and an inner longitudinal cutting edge with a shallow valley between. The coronoid is missing but the excavated surface for its articulation with the outer and inner sides of the dentary shows that its anterior extension was relatively abbreviated. If correctly referred to the present species, it quite certainly indicates that the affinities of this form do not lie in the genus *Xestops*.

The small size of the dermal scutes found with the type suggests their association with it. They differ from those of *Peltosaurus* and *Glyptosaurus* in having one end and both sides steeply beveled, as in *X. vagans*. They are asymmetrically carinate and ornamented with low tubercles of irregular size that are irregularly arranged.

Although fully realizing the inadequate nature of the type material, it appears best for the present to continue this species in the genus *Xestops*, this decision being reached more on the similarity of the scutal structure than by any characters found in the type dentary.

REFERRED SPECIMENS

No. 1094, Yale Museum. Consists of the posterior portion of a dentary bearing two complete teeth. Bridger formation, Middle Eocene, Bridger Basin, Wyoming. Collected by L. La Mothe and J. W. Chew, August, 1874.

No. 1095, Yale Museum. Consists of 10 complete scutes and fragments of several others. Bridger formation, Middle Eocene, Bridger Basin, Wyoming. Collected by O. Harger, September 15, 1871.

?XESTOPS MINUTUS (Marsh)

(Pl. 2, figs. 11, 12)

Oreosaurus minutus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 308.
Xestops minutus (Marsh) Cope, E. D., Synop. New Vertebrata from Tertiary of Colorado, Washington, October, 1873, p. 19 (generic reference).—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 48.

Type specimen.—Yale University Museum, catalogue No. 1058. Consists of anterior end of dentary with one complete tooth. Collected by O. C. Marsh, September 15, 1871.

Type locality.—Henry's Fork, Uinta County, Wyoming.

Horizon.—Horizon C or higher, Bridger formation, Middle Eocene.

Original description.—A very diminutive lizard with teeth closely resembling those of *Oreosaurus*, is indicated among our Wyoming fossils by some fragments of jaws and other less characteristic remains, belonging to several individuals, which differed somewhat in size, but agreed in their more important characters. The teeth in these specimens are cylindrical, slender, with small bases and sharp summits. They are near together and curve slightly inward. The rami of the lower jaw were quite slender and apparently united together only by cartilage. Several vertebrae were obtained by our party which probably pertain to this species. The remains preserved indicate reptiles not more than 6 or 8 inches in length.

Measurements

	Mm.
Space occupied by eight anterior teeth of lower jaw	2.2
Depth of jaw below eight lower teeth	1.5
Thickness of jaw at this point	.8
Space occupied by four upper teeth of larger specimen	2.0

The anterior portion of a dentary containing one complete tooth so closely resembles that of *X. gracilis* that it is provisionally retained in the genus *Xestops*. Its very much smaller size serves to distinguish it from the preceding species. The single tooth preserved (see pl. 2, fig. 12) is simple, sharply pointed, with a long base that is compressed anteroposteriorly as in the preceding species.

Again I fail to find in the collection "other less characteristic remains" which could be assigned to this species.

The maxillary portion that contains four teeth is of the proper proportionate size for the dentary, but these teeth develop a single small denticle on the anterior border of the crown, and which does not reach the level of the main cusp. This type of lateral tooth, it should be mentioned, is often found associated in complete jaws with simple cylindric teeth in the front of the jaws such as those of the dentary. I have been unable to find associated vertebrae, although such are mentioned in the original description.

The presence of accessory denticles on the maxillary teeth strongly suggests affinities with the Iguanidae, and the discovery of better specimens may show that the proper assignment is to that family. For the present, however, the species will be retained in the genus *Xestops*.

?XESTOPS MICRODUS (Marsh)

(Pl. 2, figs. 2, 3)

Oreosaurus microdus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 308.

Xestops microdus (Marsh) Cope, E. D., Synop. New Vert. Tert. Colorado, Washington, October, 1873, p. 19 (generic reference).—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 48.

Type specimen.—Yale University Museum, catalogue No. 1056. Consists of the median part of a dentary containing three teeth, one head scute, and a fragment of a vertebra. Collected by O. C. Marsh September 24, 1871.

Type locality.—Near Henry's Fork, Uinta County, Wyoming.

Horizon.—Horizon C or higher, Bridger formation, Middle Eocene.

Original description.—Another species apparently belonging to the genus *Oreosaurus* and about as large as *O. gracilis* may be established on some isolated remains which are quite characteristic. One of these is part of a lower jaw with the teeth in excellent preservation. The latter are unusually small and slender and curve gently outward. The crowns are nearly round; the summits obtuse, somewhat compressed, and marked by irregular striae. The jaw is stout and the groove for Meckel's cartilage large.

Measurements

	Mm.
Space occupied by four teeth from near middle of lower jaw	2. 4
Depth of jaw near middle	3. 5
Width of jaw near middle	2. 0
Length of lower tooth, including base	2. 0

The wedge-shaped form of the tooth crowns marked with irregular striae are suggestively like those of other extinct Anguidae, somewhat similar teeth being found in *Xestops vagans* and in species of both *Glyptosaurus* and *Peltosaurus*. There is but little doubt that the affinities of this form are with the Anguidae, but great uncertainty exists as to its generic relationships. That it may belong in the genus *Glyptosaurus* is further suggested by the presence in the same vial with the type dentary of a dermal head scute and a fragment of a vertebra. If it could be established that the head scute was a part of the type specimen, the species would immediately fall within the genus *Glyptosaurus*, for in form and character of its tubercular ornamentation this scute closely resembles head scutes of *G. nodosus*. However, Marsh made no mention of these other parts in his original description, and there is now no way of determining whether they form a part of the type specimen. The species must, therefore, rest upon the fragment of a dentary. The incomplete nature of the specimen renders the species of doubtful value, though it will be retained in the genus *Xestops* until the discovery of better-preserved specimens discloses its true relationships.

? XESTOPS LENTUS (Marsh)

(Pl. 2, figs. 13, 13a)

Oreosaurus lentus Marsh, O. C., Amer. Journ. Sci., 3d ser., vol. 4, 1872, p. 307.

Xestops lentus (Marsh) Cope, E. D., Synop. New Vert. Tert. Colorado, Washington, October, 1873, p. 19 (generic reference).—King, C., U. S. Geol. Expl. 40th Par., vol. 1, 1878, p. 405.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 475.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 48.

Type specimen.—Yale University Museum, catalogue No. 1052. Consists of two caudal vertebrae. Collected by O. C. Marsh, September 13, 1872.

Type locality.—Henry's Fork, Uinta County, Wyo.

Horizon.—Horizon C or higher, Bridger formation, Middle Eocene.

Original description.—Another species of lizard, which may be placed provisionally in the genus *Oreosaurus*, is indicated by a number of caudal vertebrae, widely different from any hitherto known. These vertebrae are short, and have the lower surface of the centra deeply excavated, longitudinally, by a broad groove, which makes the inferior border of the articular cup and ball emarginate. The chevrons are thus attached on either side to a prominent ridge, their position being a little behind the middle of the centrum. The reptile represented by the remains preserved was apparently about 2 or 3 feet long.

Measurements

	Mm.
Length of anterior caudal vertebrae on lower surface	7. 0
Transverse diameter of articular cup	4. 4
Vertical diameter	2. 0
Distance from chevrons to end of ball	3. 5

In order that the reader may have a more intimate knowledge of the exact status of the bones that constitute the type of the present species, I will briefly review a few details which, had Marsh clearly designated the exact nature of the type material, might very well have been omitted.

A small glass vial, on the cork of which is plainly printed "Type *Oreosaurus lentus* O. C. M.," contained three vertebrae, two being caudal, the third a dorsal. The very small size of the dorsal vertebra shows at once that it could not have belonged to the same individual as the caudals, and since no mention is made of it in the original description, it may be dismissed from further consideration in this connection. The type, therefore, consists of the two caudal vertebrae, and not of "a number of caudal vertebrae" as stated in the original description.

It will also be observed that Marsh's assignment of this species to the genus *Oreosaurus* (=*Xestops*) was provisional. The uncertainty in his mind of its proper generic reference is indicated by the notation "*Glyp. lentus*, type" found on a slip of paper inserted in the vial, the abbreviation evidently standing for *Glyptosaurus*. Comparison with caudal vertebrae of that genus clearly indicates their distinctness. Since caudal vertebrae of *Xestops* are unknown at this time, it appears best to retain this species in that genus, though no adequate reason exists for so doing.

The wide and deep longitudinal channel on the ventral surface, with chevron attachments on the lateral ridges slightly posterior to the center of the centrum, at once distinguishes these from other known caudal vertebrae, though they have a slight resemblance to caudals of *G. tuberculatus* (Douglass). They may very well pertain to described forms which have been founded on other parts of the skeleton and which have not as yet been correlated with caudal vertebrae. The intercentral position of the chevron facets on lateral ridges suggests relationships in the Anguidae, but only by the discovery of more complete specimens can this suggestion be verified, and for the present I shall regard the species as of very uncertain reference.

In the vial containing the type of *Iguanavus exilis* was the anterior half of a caudal vertebra that is indistinguishable from the smaller one of the two constituting the type of ? *Xestops lentus*. That it can not belong to *I. exilis* is clearly indicated by the intercentral attachment of the chevrons in that genus and species.

?XESTOPS PAWNEENSIS, new species

Type.—No. 1281, Kansas University. Consists of the median section of an articulated skull, with the median part of the attached right ramus. Collected by Curtis J. Hesse, 1925.

Type-locality.—Thirty miles north of Sterling, sec. 28, T. 11, R. 53 W., Logan County, Colo.

Horizon.—White River formation, Oligocene.

The specimen selected as the type of this new species belongs to the paleontological collections of Kansas University and was submitted to me for study and description through the courtesy of Handel T. Martin, assistant curator of paleontology in that institution.

The skull is incomplete to the extent that the muzzle is lacking, and all of the posterior portion back of the orbits. A section of the right dentary is also retained in positon by the matrix.

Unfortunately, those parts most needed for a positive determination of its family affiliations are wanting. The presence of pleurodont teeth, a frontal that is but little excavated between the orbits and whose upper scutal surface has a granular ornamentation, frontoparietal scutes separate, not meeting on median line, pre- and postfrontals not meeting above the orbits, and the presence of rectangular osseous body scuta are all features suggesting that its affinities lie within the genus *Xestops* to which it is now provisionally referred. The tentative assignment of this specimen is largely due to differences observed in the structure of the teeth especially in the crowns as contrasted with those of the genotype *Xestops vagans.* The crowns are simple compressed with a convex anterior edge which places the acute apex on the posterior side of the tooth and gives them the appearance of raking backwards. In *X. vagans,* the teeth are more robust with swollen obtuse summits, crowned with a low longitudinal ridge with parallel wrinklings at right angles to the cutting edge. Despite these differences in tooth structure such characters as can be contrasted in the skulls seems to justify the present tentative assignment.

The teeth are closely placed subcyclindric, with upper and lower teeth indistinguishable. In the maxillary eight and one-half teeth occupy a space of 5 millimeters. In size and lack of surface ornamentation these teeth bear a striking resemblance to those of *Exostinus serratus* found in this same region, differing chiefly in their more pointed apices.

On account of the frontal bone being coossified with the overlying scutes it can not be determined whether the frontals were distinct or not. The granular surface ornamentation is similar to that in *X. vagans,* and the frontoparietal scutes are separate on the mid line as in that species. The post- and prefrontals are perhaps less widely separated above the orbits in this new species. Between the orbits the frontal bone has a width of 5 millimeters.

The orbits are large, subcircular in outline; nasals distinct. That portion of the palate still preserved, consisting of the articulated palatines and vomers,bears a strikingly close resemblance to the palatal region of *Gerrhonotus,* and apparently indicates its Anguid relationship. The vomers are in close apposition in front, separated by a fissure posteriorly, the anterior ends slightly excavated on their inferior surfaces. Palatines descending from the plane of the vomers; vomerine and maxillary processes subequal in size. Palatine foramen of good size. The presence of a single small body osteodern with the skull is all that we know of the dermal covering. Its external surface is sparsely pitted, and it shows the usually smooth overlap surface at one end.

The several close resemblances in skull structure, noted above in this incomplete specimen to such a typical Anguid as *Gerrhonotus,* seem to indicate the correctness of its assignment to the family Anguidae.

SAURIA of unknown family reference

Under this heading are recorded forms which apparently pertain to the suborder Sauria but whose systematic relationships could not be determined. Here are included many of the earlier described genera and species which were based on scanty materials, as well as a considerable number that are new, founded largely on jaw fragments, carrying teeth, chiefly from the Lance formation of Wyoming. It was with considerable hesitancy that I named the latter, but they form such an extensive addition to the known lacertilian fauna of North America that it seemed important to recognize them, and, after consultation with my colleagues, the unanimous opinion was that, since they could be differentiated, they should be named and described, even though seldom was a clue found to warrant their assignment in the classification. It is anticipated, however, that future discoveries will sufficiently augment our knowledge of these little known forms that many of them can eventually be properly classified within the suborder.

Genus CREMASTOSAURUS Cope

Cremastosaurus Cope, E. D., Synop. New Vert. from Tertiary of Colorado, October, 1873, p. 18.

Genotype.—*Cremastosaurus carinicollis* Cope.

A little known genus founded on a series of five cervical vertebrae, whose family affinities are unknown.

The reference of the type species of the genus *Platyrhachis* (*P. coloradoensis*) to the genus *Rhineüra* (see p. 42) leaves without generic designation the two remaining species *P. rhambastes* and *P. unipedalis*, both of which were founded on very scanty if not inadequate specimens. To create a new genus for the reception of such doubtful species would, perhaps, only add to the general difficulty, and, since all come from the Oliogocene of northeastern Colorado, I propose to provisionally refer them to the genus *Cremastosaurus*, a systematic position formerly assigned them by Cope.

Since the type of the genus, *C. carinicollis*, is known only from cervical vertebrae, no direct comparisons can be made with the type materials of the two species here under consideration. Cope, however, called attention to the fact that the "difference is somewhat like that which prevails between the cervical and dorsal vertebrae of many genera of the Lacertilia." That these vertebrae from cervical, dorsal, and sacral regions of the backbone all pertain to the same kind of lizard can only be ascertained by articulated or associated materials, and we must await the discovery of such before the validity of their present assignment can be ascertained.

CREMASTOSAURUS CARINICOLLIS Cope

(Pl. 25, figs. 3, 3a–3b)

Cremastosaurus carinicollis Cope, E. D., Synop. New Vertebrata from the Tertiary of Colorado, October, 1873, p. 18 (part); Ann. Rep. U. S. Geol. and Geogr. Surv. Terr. for 1873, 1874, p. 515; Rep. U. S. Geol. Surv. Terr., vol. 3, 1884, pp. 779, 781, pl. 60, fig. 16.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 447.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 38.

Type specimen.—American Museum of Natural History, catalogue No. 1604. Consists of intercentrum of atlas, axis, and four succeeding cervicals, all articulated. Collected by Prof. E. D. Cope, 1873.

Type locality.—Cedar Creek, Logan County, Colo.

Horizon.—Cedar Creek beds (Oreodon zone), White River formation, Oligocene.

Original description.—Established on a series of vertebrae which differ strongly from those of *Peltosaurus*, and from those of *Exostinus* also, if the affinity between the two genera exists, as supposed. The species is larger than either *E. serratus* or *Aciprion formosum.*

The neural arch is capacious in the cervical region, and each neurapophysis is excavated below the posterior zygapophysis and sending a ridge downward and backward round the centrum, continuing as a low shoulder on the inferior face. Diapophysis with a single narrow capitular articulation, extending obliquely downward and forward; that of the third vertebra smaller. Axis with an elevated neural arch, with obtuse, inferior carina. Odontoid a crescentic element, with a transverse groove on its anterior face. All the centra with an obtuse but prominent hypapophysial keel.

Char. specif.—Ball of sixth cervical round. Neural arches broad, each with a low, acute keel for spine which is elevated on the third, and produced roof-shaped backward and forward on the axis. The costal articulations are not produced below the centrum.

Measurements

	M.
Length of cervical vertebrae II to IV	0. 0140
Length of axis	. 0038
Elevation of axis behind	. 0047
Diameter of odontoid (in front)	. 0034
Length of c. VI	. 0029
Diameter of ball of same	. 0011
Total elevation of same	. 0030

The principal features of the type specimens are fully and accurately set forth in the above description. However, the statement that these vertebrae differ strongly from those of *Exostinus* is misleading since the vertebrae of that genus are unknown. In all of the assembled materials no other vertebrae that can certainly be identified with the type specimen were found. The character and well-preserved condition of the type material makes it appear highly probable that with the discovery of additional and better preserved specimens the family and other relationships can be fully recognized.

CREMASTOSAURUS RHAMBASTES (Cope)

(Pl. 25, figs. 8, 8a–8c)

Cremastosaurus carinicollis Cope, E. D. (in part), Ann. Rep. Geol. and Geogr. Surv. Terr. for 1873, 1874, p. 516,
Platyrhachis rhambastes Cope, E. D., Rep. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 779, pl. 60, figs. 18, 18a, 18b. 18c.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 477.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 44 (as *P. rhambestes*).

Type specimen.—American Museum of Natural History, catalogue No. 1606. Consists of seven dorsal vertebrae. Collected by Prof. E. D. Cope, 1873.

Type locality.—Horse Tail Creek, Logan County, Colo.

Horizon.—Horse Tail Creek beds (Titanotherium zone), White River formation, Oligocene.

Original description.—Established on seven dorsal vertebrae, which I formerly regarded as belonging to *Cremastosaurus carinicollis.* They differ very much from the cervical vertebrae on which the latter genus is based; too much, I believe, to render it probable that they belong to lizards of the same genus. This also in spite of the fact that the difference is somewhat like that which prevails between cervical and dorsal vertebrae of many genera of Lacertilia. The inferior carina in the *Cremastosaurus* is not a hypapophysis of the usual kind found on only a few of the cervicals, but continues undiminished to the sixth and last I possess of the series. The articular ball at this point shows no indication of the depression characteristic of the dorsals, and which is usual at this point, even in species where the anterior cervicals have subround articular extremities.

The dorsal vertebrae have transversely oval articular faces, and centra without inferior keel or ridge. The vertebrae are all dorsal, hence the diapophyses have the usual form in the order for costal articulation, and do not project as far inferiorly as the plane of the lower face of the centrum. It does not project beyond the anterior zygapophyses, and the lower half is especially developed as the costal condyle. The sides are separated from the wide, flat, inferior surface by an obtuse angle. Neural spine a keel extending from the front of the arch and rising into a short obtuse apex above the articular ball. There is a collar around the ball, which is faintly visible on the inferior side.

Measurements

	M.
Length of centrum	0. 0040
Width of cup	. 0018
Depth of cup	. 0010
Elevation of neural arch anteriorly	. 0015
Elevation of neural spine and arch posteriorly	. 0043
Total expanse in front	. 0047

The dorsals represent several individuals.

The above fully describes the principal features of the dorsal vertebrae on which this species was established. Viewed ventrally they suggest amphisbaenoid affinities (compare figs. 8a and 10b, pl. 25), but the collar around the ball, higher arch, with obtuse spinous processes and more triangular shape of the centrum, distinguished them from the low, depressed vertebrae of that family.

With the type material there is now a small fragment of a right dentary containing the basal portions of six teeth. Cope makes no mention of this jaw fragment, and I am inclined to think it was not present when the species was described. Its association with the type material is, therefore, considered very doubtful.

CREMASTOSAURUS UNIPEDALIS (Cope)

(Pl. 25, figs. 1, 1a–1b)

Diacium unipedalis Cope, E. D., Synop. New Vertebrata from Tertiary of Colorado, October, 1873, p. 18.
Cremastosaurus unipedalis Cope, E. D., Ann. Rep. Geol. and Geogr. Surv. Terr. for 1873, 1874, p. 516.
Platyrhachis unipedalis Cope, E. D., Rep. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 779, pl. 60, figs. 19, 19a, 19b.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 477.—Nopsca, F. B., Beitr. Pal. und Oester.-Ung., vol. 21, 1908, p. 44.

Type specimen.—American Museum of Natural History, catalogue No. 1605. Consists of a single sacral vertebra lacking much of the neural process. Collected by Prof. E. D. Cope, 1873.

Type locality.—Horse Tail Creek, Logan County, Colo.

Horizon.—Horse Tail Creek beds (Titanotherium zone), White River formation, Oligocene.

Original description—Char. specif.—Represented by a vertebra somewhat resembling the last [*Diacium quinquepedalis*] but very much smaller. Centrum depressed, plane longitudinally convex in transverse section. An annular groove around the ball. Diapophysis elongate, slightly depressed.

Measurements

	M.
Length of centrum	0. 0034
Diameter of cup:	
Transverse	. 0020
Vertical	. 0018

In a later publication [25] Cope adds the following:

> Represented by a sacral vertebra of an individual smaller than any of those of the last described species [*Cremastosaurus carinicollis*], and characterized by the unusual protuberance of the articular ball and absence of flattening of the centrum below.

This vertebra is absolutely unlike the sacral of *Diacium quinquepedale*, as shown by its very much smaller size, the depressed transversely convex centrum with transversely oval cup that looks forward and downward, whereas the sacral of *Diacium* is nondepressed with concave ventral surface and cup that looks almost directly forward. Except for its slightly smaller size the sacral of *C. unipedalis* might very well be referred to *C. rhambastes* as the rounded ventral surface of the centrum with groove around the ball, corresponds almost exactly with the dorsals of that species. In the event of their being found to be cospecific, *C. unipedalis* would become a synonym of *C. rhambastes* on the grounds of priority.

Hay included this species in the Amphisbaenidae, but the presence of elongate diapophyses on the sacral vertebra would oppose such an assignment, although its small size and the depressed nature of the centrum might favor it. In *Rhineüra floridana* all that remains of the pelvic arch is a single curved rod on each side that connect with the extremities of two ribs by ligaments only, and since the living and extinct forms are so very similar, in so far as they can be compared, it would seem most probable that the loss of the pelvis and the connecting processes of the sacrum had taken place before Oligocene times, although there is the possibility of *C. unipedalis* being the progenitor of the *Chirotes* group of the Amphisbaenoidae.

Inadequate though the type of this species may be, it appears best to continue its use in the hope that its true affinities can be determined.

Genus DIACIUM Cope

Diacium Cope, E. D., Synop. New Vertebrata from the Tertiary of Colorado, Washington, October, 1873, pp. 17, 18.

Genotype.—*Diacium quinquepedale* Cope.

A genus of unknown family affinities containing a single species founded on a sacral centrum from the Oligocene of Colorado.

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[25] Ann. Rep. Geol. and Geogr. Surv. Terr. for 1873, 1874, p. 516.

Diacium quinquepedale Cope

(Pl. 25, figs. 2, 2a–2c)

Diacium quinquepedalis Cope, E. D., Synop. New Vertebrata from the Tertiary of Colorado, Washington, October, 1873, pp. 17, 18.

Diacium quinquepedale Cope, E. D., Ann. Rep. Geol. and Geogr. Surv. Terr. for 1873, 1874, p. 514; Rep. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 777, pl. 60, fig. 20.—Hay, O. P. Bull. U. S. Geol. Surv., No. 179, 1902, p. 477.—Nopcsa, F. B., Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 38.

Type specimen.—American Museum of Natural History, catalogue No. 1602. Consists of a single sacral vertebra. Collected by E. D. Cope, 1873.

Type locality.—Logan County, Colo.

Horizon.—White River formation, Oligocene.

Original description—Char. gen.—Established on a vertebra of a large lizard, which presents such peculiarities as to indicate that its affinities are remote from those above described.

The diapophysis is subcylindric and elongate. Centrum concave below; neural arch flat above. Articulation without zygosphene or rudiment of it; zygapophyses oblique, the arch deeply excavated between the anterior ones. Obliquity of ball inferiorly.

Char. specif.—Two hypophysial tubercles below the ball. Centra slightly depressed, the cup excavated above and below. An angulation extends backward from each anterior zygapophysis; the neural arch between them flat on the anterior half.

Measurements

	M.
Length of centrum below	0. 0100
Diameter of articular cup:	
Transverse	. 0086
Vertical	. 0064
Diameter of base of diapophysis	. 0044
Width between anterior zygapophyses	. 0098
Width of upper plane of neural arch	. 0078

This species is as large as any of the existing species of the Varanidae.

No specimens other than the type which could be referred to this form have been found in the materials assembled for this monographic study. It might appear best to abandon the genus and species since the extremely scanty nature of the type specimen precludes the possibility of properly defining it, but I propose to continue their use in the hope that the discovery of more complete specimens may eventually place the species on an adequate foundation.

Diacium quinquepedale was assigned by Hay to the Amphisbaenidae, but there is no good reason for this. In fact, the presence of heavy diapophyses, nearly round ball, and high arch are features opposed to that assignment, all of the Amphisbaenidae, so far as is known, having a reduced pelvic arch, depressed vertebrae with transversely elliptical ball. I have been unable to obtain any clue as to its systematic position and shall therefore include it among those forms of uncertain reference.

In discussing this genus Cope says:[26]

> This genus was originally established on the sacral vertebra of a lizard which displayed the peculiarity of the absence of any trace of neural spine.

This is true so far as the neural arch is preserved, but it must be remembered that the posterior part of the arch is missing and it might very well have borne a small neural spine.

Naocephalus porrectus Cope

Naocephalus porrectus Cope, E. D., Proc. Amer. Philos. Soc., vol. 12, 1872, p. 465; Sixth Ann. Rep. U. S. Geol. Surv. Terr. for 1872, 1873, p. 632.—Hay, O. P., Bull. U. S. Geol. Surv., No. 179, 1902, p. 477.—Nopcsa, F. B., Beitr. Pal. und Geol. Oester.-Ung., vol. 21, 1908, p. 43.

Type specimen.—American Museum of Natural History, but temporarily lost. Consists of an incomplete cranium with associated vertebrae. Collected by E. D. Cope.

Type locality.—Wyoming.

Horizon.—Bridger formation, Eocene.

Original description.—Established on an incomplete cranium, with vertebrae found associated. No teeth are preserved, nor any part of the mandible. The remaining portions of the cranium, however, highly characteristic.

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[26] Rep. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 777.

The occipital descends posteriorly, and bears a pair of lateral ridges, which converge rapidly posteriorly. This bone is united with the parietal by suture, which is transverse; its outline is rectangular, so as almost to reach the frontals which are prolonged backwards on each side the parietal, leaving but a narrow exposure of the posterior processes of the parietal. These extend backward and are broken off in the specimen, but they probably formed parts of arches. The parietal is single, and there is no parietal fontanelle. The bone is triangular in outline with the apex anterior, dividing the frontals. These are contracted at the orbits and have a projecting superciliary head; anteriorly they are thickened. The postfrontals are of remarkable form. They are massive and compressed from before backwards; they rise considerably above the level of the front, and bear on their summits a cotyloid cavity, which is transverse to the axis of the cranium; the use of this projection is obscure. There is an occipital foramen, and a large one in the posterior part of the frontal opposite the postfrontal elevation.

The sphenoid is a compressed keel-shaped bone, rounded below, and with broad alae along much of its length. The occipital condyle is subcordate depressed in outline, with a vertical obtuse angle in the middle and the sides somewhat plane.

A dorsal vertebra preserved has a single vertical capitular process, and a short hypapophysis. The neural canal is large, and the neurapophyses are attached by sutures. The cup is nearly round, very slightly transverse, and in vertical plane.

The cranium is smooth above except the anterior part of the frontals, which are finely rugose.

The genus is more or less allied to the Thecoglossa, but better material will be requisite to decide the question of affinities fully.

Found with the preceding specimens.

Measurements

	M.
Width of cranium at postfrontals	0. 072
Width of parietal behind	. 012
Depth postfrontal	. 018
Depth presphenoid anteriorly	. 014
Diameter dorsal vertebra (cup)	. 007

This genus differs from *Glyptosaurus* Marsh in the total lack of cranial shields, and from *Saniwa* Leidy, in the nearly round vertebral centra.

It is most unfortunate that the type materials of this species have been mislaid, since it is one of the few known specimens from the Bridger formation having skull and vertebral elements associated. The type has never been illustrated, and from the rather brief description it can not be identified with any of the numerous scattered remains now known from that formation. For the present, however, it seems best to continue the genus and species in the hope that the type materials will be again located.

Cope, although registering some doubt, regarded the affinities of this form to be with the Thecoglossa Sauria. Hay, however, referred it to the Amphisbaenidae, remarking that it was "a genus of uncertain affinities." A brief review of the original description is sufficient to show that it can not belong to that family. The presence of a postorbital bone is perhaps sufficient to exclude it from the Amphisbaenidae, but the occurrence of a foramen in the posterior part of the frontal, together with a dorsal vertebra having a nearly round cup, are all features opposed to amphisbaenoid relationships. The proper systematic position of *Naocephalus porrectus* is unknown, and for the present, at least, I agree with Nopcsa that this form should be regarded as *incertae sedis*.

MACHAEROSAURUS TORREJONENSIS, new genus and species

(Pl. 4, fig. 5)

Type specimen.—American Museum of Natural History, No. 5184. Consists of a fragmentary skull and lower jaws, with a few teeth. Collected by W. J. Sinclair August 30, 1913.

Type locality.—East fork Torrejon Arroyo, San Juan County, N. Mex.

Horizon.—Torrejon formation, Paleocene.

The imperfect specimen selected as the type of the present genus and species, although quite fragmentary, nevertheless displays features which appear to definitely distinguish it from all other described forms.

It is quite evident that the parts preserved are the remains of an unusually perfect skull, as shown by impressions in the matrix made by the missing elements which were destroyed before its discovery. Of the left side there are still preserved the posterior half of the maxillary carrying teeth, the lachrymal, prefrontal, orbital rim of frontal, a narrow border of the parietal, the anterior end of the jugal, and a considerable part of the ramus. Of the right side there remain a fragment of the maxillary and the median portion of the ramus. See Figure 97.

The frontal, parietal, and upper portion of the maxillary bones have their surface sculptured by a distinctive roughening which may be described as *punctate-vermiculate*. I have failed to find among living lizards any sculpturing closely resembling it, and among fossil forms none with which it can be confused. This ornamentation of the cranial bones in conjunction with tooth characteristics appear sufficient to definitely distinguish the genus and species. The bones of the left side are so little disturbed from their normal relationships as to show the subcircular shape and large size of the orbit, which has a greatest vertical diameter of 7 millimeters. The frontal participates in the formation of the upper boundary of the orbital rim. The prefrontal is large and sends backward and upward a slender pointed process which underlaps the forward outer border of the frontal, but is terminated in advance of the center of the orbit.

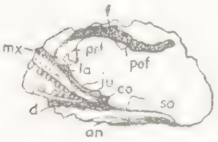

Fig. 97.—Skull and lower jaws of *Machaerosaurus torrejonensis* Gilmore. Type. (No. 5184, Amer. Mus. Nat. Hist.) About twice natural size. Viewed from the left side. *an*, angular; *co*, coronoid; *d*, dentary; *ju*, jugal; *f*, frontal; *la*, lachrymal; *mx*, maxillary; *pof*, postfrontal; *prf*, prefrontal; *sa*, surangular

The vermiculate sculpturing on the maxillary vanishes toward the alveolar border leaving a narrow, smooth band which is perforated at intervals by a row of foramina. The incomplete left maxillary shows evidence of having carried eleven teeth; eight of these occupy a space 5 millimeters in length. The teeth of both upper and lower jaws have simple, compressed, sharply pointed, slightly recurved, dagger-like crowns with sharp cutting edges both front and back. In cross section the bases of the crowns would be lenticular fore and aft.

All of the elements of the mandible, so far as they can be observed, are distinct. The dentary appears to extend behind the coronoid on the external face of the jaw. The coronoid is moderately produced forward on the outside of the dentary and less so backward. It has a decided upward prolongation. The surangular is incomplete but appears to be slender, is in about the same vertical plane as the dentary, and is elongated posteriorly. The posterior angle of the ramus is obscure. The skull is slightly larger than the cranium of a large *Gerrhonotus*.

Beyond determining its undoubted lacertilian affinities, I have been unable to arrive at any conclusion as to the family or other relationships of this form.

Genus Harpagosaurus, new genus

Genotype.—*Harpagosaurus parvus*, new species.

Characters.—Dentition pleurodont; teeth simple, slender, subround shafts, conical and compressed sharp apices, that curve slightly backward. More than 14 teeth in complete maxillary series, 17 or 18 in complete dentary series.

A genus of unknown family affinities. Two species are nere recognized, *Harpagosaurus parvus*, from the Lance, Upper Cretaceous, of Wyoming, and *H. excedens*, from the Fort Union No. 2, Paleocene, Sweetgrass County, Mont.

Key to species

Tooth crowns usually conical, acutely pointed, curved backward and inward	*H. parvus*
Tooth crowns slightly compressed, sharply pointed, curved slightly backward	*H. excedens*

Harpagosaurus parvus, new species

Type specimen.—United States National Museum, catalogue No. 10803. Consists of a right maxillary bearing 14 teeth, 8 of which are complete. Collected by J. B. Hatcher, 1889.

Type locality.—"Peterson's Quarry," Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

The specimen selected as the type consists of the greater portion of a right maxillary, bearing evidence of the presence of 14 teeth. The teeth are typically pleurodont, simple, slender, with conical, sharply pointed crowns that curve slightly backward and inward. The shafts of the teeth are consistently long and cylindrical, with their walls hollowed out at the base. The fourth tooth from the posterior end (see A, fig. 98) has a transversely compressed crown instead of conical as in those more anterior, and there is a faint suggestion of an anterior denticle, but it is not distinctly marked off. Twelve teeth occupy a space of 5 millimeters. The character of the dentition suggests affinities with the Iguanidae.

HARPAGOSAURUS EXCEDENS, new species

Type specimen.—United States National Museum, catalogue No. 10447. Consists of a left maxillary containing teeth and lacking the anterior end. Collected by A. C. Silberling.

Type locality.—Sec. 4, R. 16 E., T. 5 N., Sweetgrass County, Mont.

Horizon.—Fort Union No. 2, Paleocene.

A nearly perfect left maxillary bone showing evidence of 15 teeth is provisionally referred to the genus *Harpagosaurus*. That its affinities may lie in this genus is suggested by resemblances found in the shape and method of implantation of the teeth, but the unreliable nature of these criteria leads me to regard the assignment as tentative only.

The teeth are typically pleurodont, with long, subround shafts and slightly compressed but pointed crowns that curve backward. In all of these respects the teeth resemble those of the genotype, except for their slightly larger size and the more sharply pointed crowns of *H. parvus*. Broken teeth show that the walls of the tooth shafts are considerably thicker than in the type species. These differences, taken into consideration with its geological occurrence, point to the specific distinctness of the species. In the maxillary of *H. parvus*, 12 teeth occupy a space of 5 millimeters, while in *H. excedens* there are 11 teeth in the same distance.

A left dentary (No. 10445, U. S. National Museum) from the same locality and horizon as the type specimen is provisionally referred to this species. This dentary shows the complete dentition as consisting of either 17 or 18 teeth. These are slightly larger and extend farther beyond the parapet of the jaw than in either *H. parvus* or the type specimen of the present species. The form of the crowns approaches that of *H. parvus* rather than that of the type of *H. excedens*.

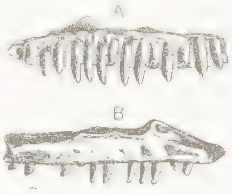

FIG. 98. Right maxillary of *Harpagosaurus parvus* Gilmore. Type (No. 10893, U. S. Nat. Mus.) About five times natural size. A, inner view; B, outer view

The principal features of both the maxillary and dentary referred to this species are well shown in Figures 99 and 100.

MEGASAURUS ROBUSTUS, new genus and species

(Pl. 27, figs. 1, 1a)

Type specimen.—United States National Museum, catalogue No.2910. Consists of an anterior caudal vertebra. Collected by O. A. Peterson, 1889.

Type locality.—"Peterson's Quarry," Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

The specimen selected as the type of the present genus and species was originally referred to *Chamops segnis* by Marsh, being one of the vertebrae mentioned in the concluding paragraph of his original description of that form (see p. 25). Although, as stated by Marsh, "various vertebrae" were found at the same locality as the type of *C. segnis*, none was positively associated. The robust character of this vertebra, which is all out of proportion to the size of the type maxillary of *C. segnis*, together with certain distinctive characters to be described, precludes its assignment to that species, if not to the genus, and shows the presence in the Lance formation of a large, unnamed lizard. Though fully recognizing the scanty character of the material, I propose the name *Megasaurus robustus* for its reception, trusting that the discovery of more perfect specimens will eventually disclose its true relationship.

The vertebra, on account of the absence of parapophyses, a flattened ventral surface, no chevron facets, and the probable presence of transverse processes, is regarded as an anterior caudal. The cup is subtriangular in outline and faces downward and forward. The ball is pointed and subtriangular in shape when viewed from the end. Its pointed condition is probably due somewhat to the abrasion of its surfaces. The vertebra is without zygosphenal articulation. The flattened ventral surface is relatively narrow transversely, being deeply grooved by two parallel, longitudinal grooves that extend the whole length of this surface. The grooves are separated at the center by a flattened ridge that in width equals that of the lateral grooves. This feature appears to be distinctive of this form, but whether it persists in the other members of the vertebral series there is of course no way of determining. In all of the large assemblage of lacertilian materials from North America I fail to find another vertebra having similar features. Laterally the side of the centrum has a pronounced oblique ridge running longitudinally along the side at about the level of the neural canal. It is thought that a small transverse process was developed at the center of this ridge but the wear to which the specimen has been subjected makes it uncertain as to whether the slight projection represents the complete process or only its broken base smoothed off by abrasion. The top of the spinous process is broken off, but it is compressed transversely and narrow fore and aft. A median anterior ridge, commencing at the posterior termination of the prezygapophyses, extends backward and upward to the base of the spinous process. Near its anterior end on either side are transversely narrow but decided depressions.

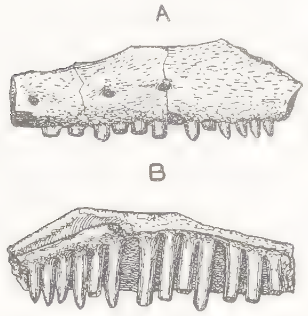

FIG. 99.—Left maxillary of *Harpagosaurus excedens* Gilmore. Type. (No. 10447, U. S. Nat. Mus.) About five times natural size. A, outer view; B, inner view

Measurements

	Mm.
Greatest length of centrum	21. 0
Greatest width of anterior zygapophyses	14. 0
Greatest width of posterior zygapophyses	11. 5
Greatest width of cup	10. 0
Greatest height of cup	6. 5

An incomplete parietal bone (No. 1063, Yale Museum) from the same locality as the type is shown in Plate 27, Figure 3. This is the specimen mentioned by Marsh in the original description of *Chamops segnis* (see p. 26) and was regarded by him as pertaining to that species. Its large size, however, as is the case with the vertebra here described, shows that it belongs to a much larger animal, and I therefore provisionally refer it to the present species. The parietal is perforated by a large oval foramen forward of its center. The superior surface is roughened, with a decided median channel running posteriorly to the broken end on the median line, as is well shown in Plate 27, Figure 3. From the character of the surface it would appear that osseous scutes were not present on the top of the head at least.

The very large size, as indicated by the type vertebra, together with the channeled ventral surface of the centrum, are features which seem to fully distinguish *Megasaurus robustus* from all other described forms of the Sauria.

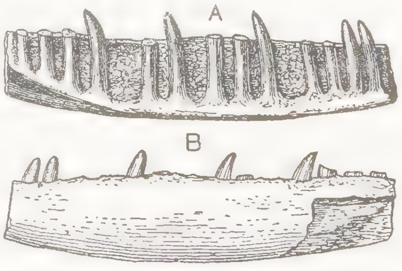

FIG. 100.—Left dentary *Harpagosaurus excedens* Gilmore. (No. 10445, U. S. Nat. Mus.) About five times natural size. A, inner view; B, outer view

ODAXOSAURUS OBLIQUUS, new genus and species

(Pl. 26, figs. 3, 5)

Type specimen.—United States National Museum, catalogue No. 10751. Consists of the median portion of a right dentary containing four complete teeth. Collected by J. B. Hatcher.

Type locality.—Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

An apparently new genus of extinct lizards is represented by the median portion of a right dentary bearing four complete teeth. The teeth are pleurodont, placed close together, with long shafts that are flattened anteroposteriorly. The apices of the teeth are slightly expanded anteroposteriorly, but compressed transversely into a subacute cutting edge that runs oblique to the longer diameter of the ramus, as does the whole shaft of the tooth, the anterior part of the cutting edge being farthest away from the outer alveolar border. The inner bevel of the crown is much longer than the outer, somewhat resembling *Peltosaurus* in this respect. The outer as well as the inner crown surfaces have delicate parallel wrinkles that run at right angles to the cutting edge. This sculpturing can be observed only under the microscope. The bases of the teeth are slightly expanded with a basal foramen. The type dentary as preserved has a greatest length of 6.8 millimeters, and four teeth occupy a space of 2.8 millimeters. Externally the teeth appear to be ankylosed to the dentary bone.

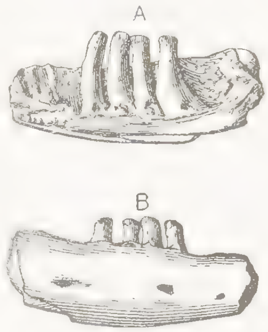

FIG. 101.—Right dentary of *Odaxosaurus obliquus* Gilmore. Type. (No. 10751, U. S. Nat. Mus.) About five times natural size. A, inner view; B, outer view

Resemblances in the teeth and manner of emplacement suggest relationship with the Anguidae, but of this I am uncertain.

The anterior end of a right dentary bearing one complete tooth and the bases of several others (No. 10801, U. S. National Museum) is tentatively referred to this genus and species. It has the same obliquity of the teeth as in the type and the same anteroposterior flattening of the shaft of the single tooth preserved intact in this specimen. Meckel's groove is shown as running to the symphysis.

A median portion of a right dentary containing one complete tooth and the basal portions of five others (No. 10804, U. S. National Museum) is also referred to this species. (Compare figs. 101 and 102.) Because of the longer projection of the crown above the parapet of the jaw, this specimen was at first thought to represent a distinct species, but it agrees so perfectly with the type in all other respects that there seems every reason for regarding it as a true member of *O. obliquus*. It was collected by J. B. Hatcher from the same geological horizon and locality as the type specimen.

Other referred specimens are No. 114, American Museum of Natural History, consisting of a fragment of jaw containing two posterior teeth, and No. 10918, United States National Museum, a fragment of a maxillary bearing four teeth. Both are from Niobrara County, Lance formation, the former having been collected by the American Museum's expedition of 1892 and the latter by J. B. Hatcher in 1889.

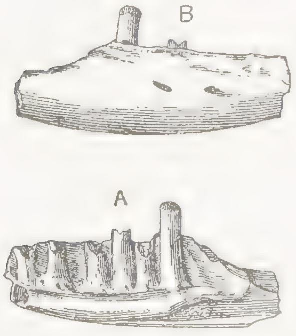

FIG. 102.—Portion of right dentary of *Odaxosaurus obliquus* Gilmore. (No. 10804, U. S. Nat. Mus.) About five times natural size. A, inner view; B, outer view

PRIONOSAURUS REGULARIS, new genus and species

(Pl. 26, fig. 1)

Type specimen.—United States National Museum, catalogue No. 10750. Consists of an incomplete maxillary containing eight teeth. Collected by J. B. Hatcher, 1892.

Type locality.—Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

The maxillary selected as the type of this genus and species appears to belong to the right side, although its incompleteness renders its exact allocation somewhat uncertain. The distinctness of the present form is indicated by characters observed in the teeth which are relatively short, uniform in size, compressed transversely, with obtusely pointed crowns. The tips of the teeth are capped by distinctly marked coverings of black enamel, as contrasted with the yellowish white of the shafts. Nine teeth occupy a space of 5 millimeters.

In cross section at about the level of the parapet of the jaw the teeth would be subtriangular, with the transverse diameter equal to, if not exceeding, the anteroposterior diameter. As preserved this specimen has a greatest length of 6.1 millimeters.

Genus LANCEOSAURUS, new genus

Genotype.—*Lanceosaurus hatcheri*, new species.

Characters.—Dentition pleurodont; teeth relatively short, gradually widening from top to base, crowns obtusely pointed. Basal portions of teeth in contact or distinct.

Two species, *Lanceosaurus hatcheri* and *L. compressus* are assigned to this genus.

Key to species

Basal portions of teeth in contact ---------- *L. hatcheri.*
Basal portions of teeth distinctly separate ---------- *L. compressus.*

LANCEOSAURUS HATCHERI, new species

(Pl. 26, fig. 8)

Type specimen.—United States National Museum, catalogue No. 10706. Consists of the greater portion of a left dentary containing teeth. Collected by J. B. Hatcher, 1891.

Type locality.—Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

This species, the type of the genus, is represented by four specimens, two of which, however, are provisionally referred. The specimen selected as the type consists of a left dentary containing three perfect teeth and the greater portion of nine others. The teeth are transversely compressed, obtusely pointed, with widened bases, are closely placed in the jaw, and are completely ankylosed to the outer parapet. They decrease rapidly in size from back to front and the small anterior teeth have their basal portions narrowed fore and aft, with a strong inclination of the crown forward from the vertical.

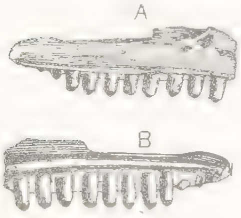

FIG. 103.—Portion of maxillary of *Prionosaurus regularis*, Gilmore. Type. (No. 10750, U. S. Nat. Mus.) About five times natural size. A, outer view; B, inner view

While the dentition may be called pleurodont, the extension of the bases of the teeth downward on the inner side of the jaw is relatively short so that the difference in relative height of the inner and outer parapets is much less than in typical pleurodont lizards. In the type dentary there is evidence of no less than 18 teeth, those in the front having the basal portion very much compressed anteroposteriorly and the roots not visible in the figures. Six of the largest teeth occupy a space of 4.3 millimeters. The posterior end of the dentary is incomplete, but as preserved it measures 10 millimeters in length. It tapers gradually to a slender anterior extremity which curves inward slightly toward the median symphysis. Meckel's groove rapidly narrows from the back toward the front, though it continues forward to the symphysis on the ventral side at the anterior end. On the external surface (see fig. 104B) is the usual row of foramina. Wherever the teeth have the tips broken off their hollow nature is revealed. The principal features of the type specimen are well shown in Figure 104 and also in Plate 26, Figure 8.

The species is named for the late J. B. Hatcher, who collected the type specimen.

Two other specimens in the collection of the United States National Museum (Nos. 10807 and 10808) are thought to belong to the present genus, although their smaller size suggests the possibility of their representing a distinct species. For the present, however, it seems preferable to provisionally refer them to *L. hatcheri*. Specimen No. 10807 is an incomplete right maxillary containing 10 teeth which occupy a space of 5.2 millimeters. These teeth are more uniform in size than those of the type dentary and project but slightly from the jaw, but in method of implantation and other characteristics they are in perfect agreement with those of the type specimen. No. 10808 is a portion of a right dentary bearing bases of teeth. Both of these are from the type locality and horizon and were collected by J. B. Hatcher.

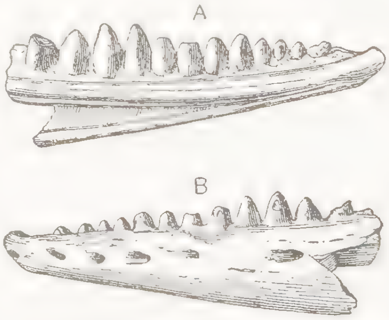

FIG. 104.—Left dentary of *Lanceosaurus hatcheri* Gilmore. Type. (No. 10706, U. S. Nat. Mus.) About five times natural size. A, inner view B, outer view

The geographical range of the genus is considerably extended by the discovery of a fragmentary dentary carrying teeth in the Lance deposits on Rocky Creek, in southern Saskatchewan. This specimen, which is clearly referable to *L. hatcheri*, is No. 2911 in the collection of the Geological Survey of Canada and was collected by Mr. C. M. Sternberg in 1921.

LANCEOSAURUS COMPRESSUS, new species

Type specimen.—American Museum of Natural History, catalogue No. 116. Consists of the posterior dentigerous portions of a right dentary containing eight teeth. Collected by American Museum expedition, 1892.

Type locality.—Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

A posterior portion of a right dentary bearing eight teeth has a dentition and method of implantation resembling *Lanceosaurus hatcheri*, on account of which it is provisionally referred to that genus. The more widely spaced teeth with bases less expanded anteroposteriorly shows its specific distinctness. As in *L. hatcheri*, the teeth of *L. compressus* are transversely compressed, obtusely pointed, suboval in cross section at the alveolar border, and completely ankylosed to the outer parapet of the jaw. They differ from *L. hatcheri* in being distinctly spaced and in the more restricted fore-and-aft expansion of their basal portion. (See figs. 104 and 105.) Dentition subpleurodont as in *L. hatcheri*. Six teeth occupy a space of 4.3 millimeters. Total length of dentary fragment 6.8 millimeters.

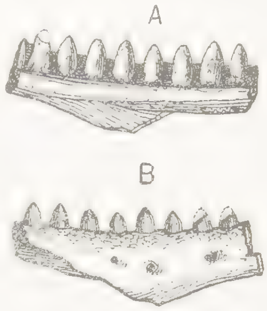

FIG. 105.—Posterior portion of right dentary of *Lanceosaurus compressus* Gilmore. Type. (No. 116, Amer. Mus. Nat. Hist.) About five times natural size. A, inner view; B, outer view

HABROSAURUS DILATUS, new genus and species

(Pl. 26, figs. 7, 9)

Type specimen.—United States National Museum, catalogue No. 10749. Consists of the greater portion of a left dentary carrying four complete teeth and the basal portions of several others. Collected by J. B. Hatcher, 1892.

Type locality.—Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

Characters which seem to indicate its distinctness from other genera and species of the Sauria are exhibited in a posterior portion of a left dentary containing four complete teeth and the basal portions of several others. The rapid vertical widening of the dentary from front to back and the teeth with expanded crowns and truncated upper surfaces appear to definitely distinguish this from all other described lizards.

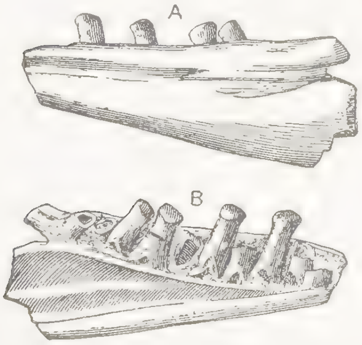

FIG. 106.—Left dentary of *Habrosaurus dilatus* Gilmore. Type. (No. 10749, U. S. Nat. Mus.) About five times natural size. A, outer view; B, inner view

Dentition pleurodont; shafts of teeth compressed anteroposteriorly; closely placed; crowns expanded fore and aft, overhanging shaft, with low, obtusely beveled surfaces, without ornamentation. Six teeth occupy a space of 6.2 millimeters. Teeth slightly reduced in size toward the posterior part of the series. Dentary bone, relatively deep posteriorly and probably short. Meckel's groove extensive. Well defined notch on upper posterior border for articulation of coronoid. Border below notch vertically truncated as shown in Plate 26, Figure 9. The lower posterior portion of the dentary is missing in this specimen, as is the anterior end.

Measurements

	Mm.
Greatest length as preserved	9.1
Greatest vertical depth of dentary	4.9
Six teeth occupy a space of	4.0

REFERRED SPECIMENS

No. 10817, United States National Museum. A left dentary with broken bases of teeth. Lance formation, Upper Cretaceous, Lance Creek, Niobrara County, Wyo. Collected by J. B. Hatcher.

No. 10813, United States National Museum. A left dentary with teeth missing. Lance formation, Upper Cretaceous, Lance Creek, Niobrara County, Wyo. Collected by J. B. Hatcher.

ALETHESAURUS QUADRATUS, new genus and species

(Pl. 26, fig. 13)

Type specimen.—United States National Museum, catalogue No. 10802. Consists of a fragment of a maxillary containing four complete teeth. Collected by J. B. Hatcher, 1891.

Type locality.—Quarry No. 1, Lance Creek, Niobrara County, Wyo.

Horizon.—Lance formation, Upper Cretaceous.

A fragment of a maxillary bearing four perfect teeth has such distinctive characters as to warrant its description as a new genus and species of the Sauria, and the name *Alethesaurus quadratus* is proposed for its reception.

The teeth, while they may be termed subpleurodont, are inserted almost on the parapet of the jaw. This dentition is intermediate between the acrodont and pleurodont. The manner of insertion and the general shape of the teeth resemble some of the posterior lateral teeth of *Tupinambis nigropunctatus*, suggesting possible affinities in the family Teiidae. The four teeth are subequal in height and in other dimensions. They are short, stout, with obtusely pointed crowns that are devoid of ornamentation and occupy a space of 4.7 millimeters. On the outside a median tooth projects nine-tenths of a millimeter below the jaw.

The teeth are subelliptical in cross section, the anteroposterior exceeding the transverse diameter. The sharp rounded apex is centrally placed anteroposteriorly, but turns inward transversely. Viewed externally, the crown proper is equilaterally triangular. Fore and aft at the base of the cutting edge is a suggestion of a vestigial denticle, though none is distinctly developed. The teeth are closely placed in the jaw and the bases have but slight expansion.

This was the only specimen of its kind found in the large assemblage of lizard remains from the Lance formation at my command.

Genus CTENIOGENYS, new genus

Genotype.—*Cteniogenys antiquus*, new species.

Represented by dentary bones containing numerous teeth.

Characters.—Dentary long and slender. Teeth pleurothecodont, closely placed, cylindric, with slightly compressed crowns. Dentary teeth in excess of 25. Meckel's groove confined to inner surface of dentary. Assignment to the Sauria uncertain as additional information may show this form to belong to the Amphibia.

CTENIOGENYS ANTIQUUS, new species

(Pl. 20, figs. 13, 14)

Undetermined reptile? Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 37, 1909, p. 40, pl. 11, fig. 4.

Type specimen.—United States National Museum, catalogue No. 6134. Consists of the median portion of the left dentary containing numerous teeth. Collected by O. C. Marsh party.

Paratype.—Yale Museum, catalogue No. 1068. Consists of the anterior portion of a right dentary containing teeth. Collected by W. H. Reed, 1882.

Type locality.—Both specimens from "Quarry No. 9," Como, Albany, Wyo.

Horizon.—"Mammal layer," Morrison formation, Upper Jurassic.

In 1909 I briefly described and figured, without name, the portion of a left dentary shown in Plate 20, Figure 13. At that time I was unable to decide on the affinities of the specimen and deferred naming it in the hope that more diagnostic material would be discovered. After further study of the specimen in conjunction with several others found in the Yale collection it seems, although doubtful, that in these materials we have the first representatives of the Sauria to be found in the Morrison formation. If this diagnosis proves to be correct, *Cteniogenys antiquus* is the most ancient lizard yet found in North America. This occurrence is not altogether unexpected, as Broom has reported a true lacertilian from the Triassic of South Africa,[27] and others are known from the Jurassic of Europe.

The type of the present genus and species consists of the median portion of a left dentary in which there are 25 teeth still preserved. The dentary, which is broken at both ends, is relatively long and slender, gradually tapering in height from the back toward the front, and measures 21 millimeters in length, with a vertical diameter at the posterior end of 3 millimeters and of 1.6 millimeters at the anterior end. The paratype, which shows the complete symphysial end, has a vertical diameter of but 0.8 millimeter.

The external surface, which is convex dorsoventrally, is pierced at intervals by foramina which run in a line parallel to the alveolar border. On the lower internal side a longitudinal groove runs to the symphysis, as is clearly shown in the paratype (see pl. 20, fig. 14). The symphysis is small and weak and evidently ligamentous.

The teeth may be regarded as pleurothecodont—that is, the roots are ankylosed to the internal side of the dentary, though relatively they do not extend down so far as in typically pleurodont lizards. The dental series is composed of small cylindrical pointed teeth with the crowns slightly compressed transversly. They are similar in shape and size, except that the anterior ones may be slightly smaller, with the crowns raking slightly backward. In a space of 10 millimeters there are 15 teeth. A median tooth extends 0.9 millimeter above the parapet of the dentary. The teeth are hollow, as shown by the broken bases in the paratype.

The Meckelian groove appears to have been exposed at the anterior end, as in the Varanidae, though more posteriorly, as shown by the paratype, it was covered by the overlying splenial. This bone is absent, but shallow convergent markings on either side of the groove indicate its anterior extent.

Geological occurrence.—The deposit from which the specimens were obtained was designated by the collectors as "Quarry 9." It was from this quarry that most of the Jurassic mammals described by Marsh were found, which adds to the interest of the contemporaneous reptilian fauna. A stratigraphic section of Como Bluff, by Loomis,[28] designates the horizon of the mammal quarry as No. 24 of his section. He describes it as follows:

> In the Como Bluff, this layer has sandwiched into it a 4-foot bed of sandstone. The sandstone is of interest as marking the horizon at which the few Jurassic mammals were found. The mammal layer is the 6 inches of clay underlying this sandstone. Most of the American Jurassic mammal remains thus far found have come from one quarry, worked most successfully by Marsh and later by the American Museum. This pocket seems to be exhausted.

The mammal layer as measured by Loomis is 80 feet below the overlying Dakota and 22 feet below the level where the American Museum parties collected skeltons of *Brontosaurus* and *Diplodocus*. It was in this same deposit that remains of the rhynchocephalian reptile *Opisthias rarus* Gilmore[29] were first obtained.

REFERRED SPECIMENS

No. 1067, Yale Museum. Consists of a considerable portion of a right dentary containing numerous teeth. Collected by W. H. Reed, 1881.

No. 1084, Yale Museum. Consists of the median portion of a dentary containing teeth. Collected by W. H. Reed, 1881.

No. 1085, Yale Museum. Consists of the median portion of a dentary containing teeth. Collected by W. H. Reed, 1879.

No. 1086, Yale Museum. Consists of the posterior half of the right dentary containing teeth. Collected by W. H. Reed and Arthur Lakes, 1879.

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[27] Broom, R., Records of the Albany Museum, vol. 1, pt. 1, 1903, pp. 1–3, pl. 1, figs. 1, 2.

[28] Loomis, F. B., Bull. Amer. Mus. Nat. Hist., vol. 14, 1901, pl. 27, fig. 2.

[29] Proc. U. S. Nat. Mus., vol. 37, 1909, pl. 35–37, pl. 11, fig. 1.

No. 1087, Yale Museum. Consists of the anterior end of a right dentary. Collected by W. H. Reed, 1879.

No. 1088, Yale Museum. Consists of fragmentary portions of a dentary containing teeth. Collected by W. H. Reed, 1881.

No. 1089, Yale Museum. Consists of the greater portion of a left dentary containing evidence of 26 teeth. Collected by W. H. Reed.

No. 1090, Yale Museum. Consists of a portion of a dentary containing teeth. Collected by W. H. Reed, 1881.

All of the above are from "Quarry No. 9," Como, Albany County, Wyo.

SAURIA undetermined

Lacerta Merriam, J. C., in Lawson, A. C., U. S. Geol. Surv.; folio No. 193, 1914, p. 14.

Specimen.—University of California, catalogue No. $\frac{10829}{19828}$. Consists of a portion of the dentary bone.

Locality.—Bald Peak, San Francisco Quadrangle, Calif.

Horizon.—Clays of the Siesta formation, Pliocene.

In the United States Geological Survey folio cited above, Lawson mentions the occurrence of "the dentary bone of a species of Lacerta." Through the kindness of Dr. Chester Stock, I have had the privilege of examining the specimen upon which this statement was based. It is so fragmentary as not to be determinable, though it clearly belongs to the suborder Sauria. The specimen is of interest as being the second reported occurrence of fossil lizards from the Pacific coast region, and the second one from the Pliocene of North America. Cope mentions [30] that "a single species was found by one of my parties in the John Day beds of Oregon." No lacertilian remains from that region have come into my hands; neither have I found other references in the literature.

The dentary from the Siesta formation was found associated with the skull of a beaver, *Sigmogomphinus lecontii*, and teeth of a species of *Lepus*.

Since the fragmentary nature of this specimen precludes its identification as belonging to the genus *Lacerta*, it should be referred to by some more general term as lacertilian or lizard.

SAURIA undetermined

(Pl. 11, figs. 4, 4a, 4b)

Among the lacertilian materials transmitted to me from the American Museum of Natural History was a single dorsal vertebra (No. 1309) which represents an undescribed member of the North American Sauria. According to the label accompanying this specimen, it was found with a mixed lot of material from New Jersey belonging to the Cope collection. Its history otherwise is unknown, though it is doubtfully regarded as coming from the Cretaceous. Because of these uncertainties, I have refrained from naming it, although it displays characters which appear sufficiently diagnostic to fully establish its identity.

With the exception of the loss of the neural spine and the abrasion of the costal facets, the bone is in an excellent state of preservation. Its large size, long tapering centrum, and strongly developed zygosphen-zygantrum articulation suggest its affinities to be either in the Lacertidae or Iguanidae. The tapering centrum with cup looking more forward than downward, and strongly developed zygosphenes, and without constriction of the centrum anterior to the ball, effectually bars it from inclusion in the Platynota.

The principal features of this specimen are well shown in the figures. Its chief interest lies in the fact that it represents the only remains of Sauria as yet found in the State of New Jersey.

Measurements

	Mm.
Greatest length of centrum	23
Greatest width across costal facets	27
Greatest width across posterior zygapophyses	19
Greatest width of cup	15

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[30] Rep. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 770.

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DESCRIPTION OF PLATES

PLATE 1

AMPHISBAENIDAE

FIG. 1. *Hyporhina antiqua* Baur. Type. No. 11390, Princeton Museum. Skull and lower jaws, viewed from the left side. × 4

1a. The same, top view.

1b. The same, ventral view.

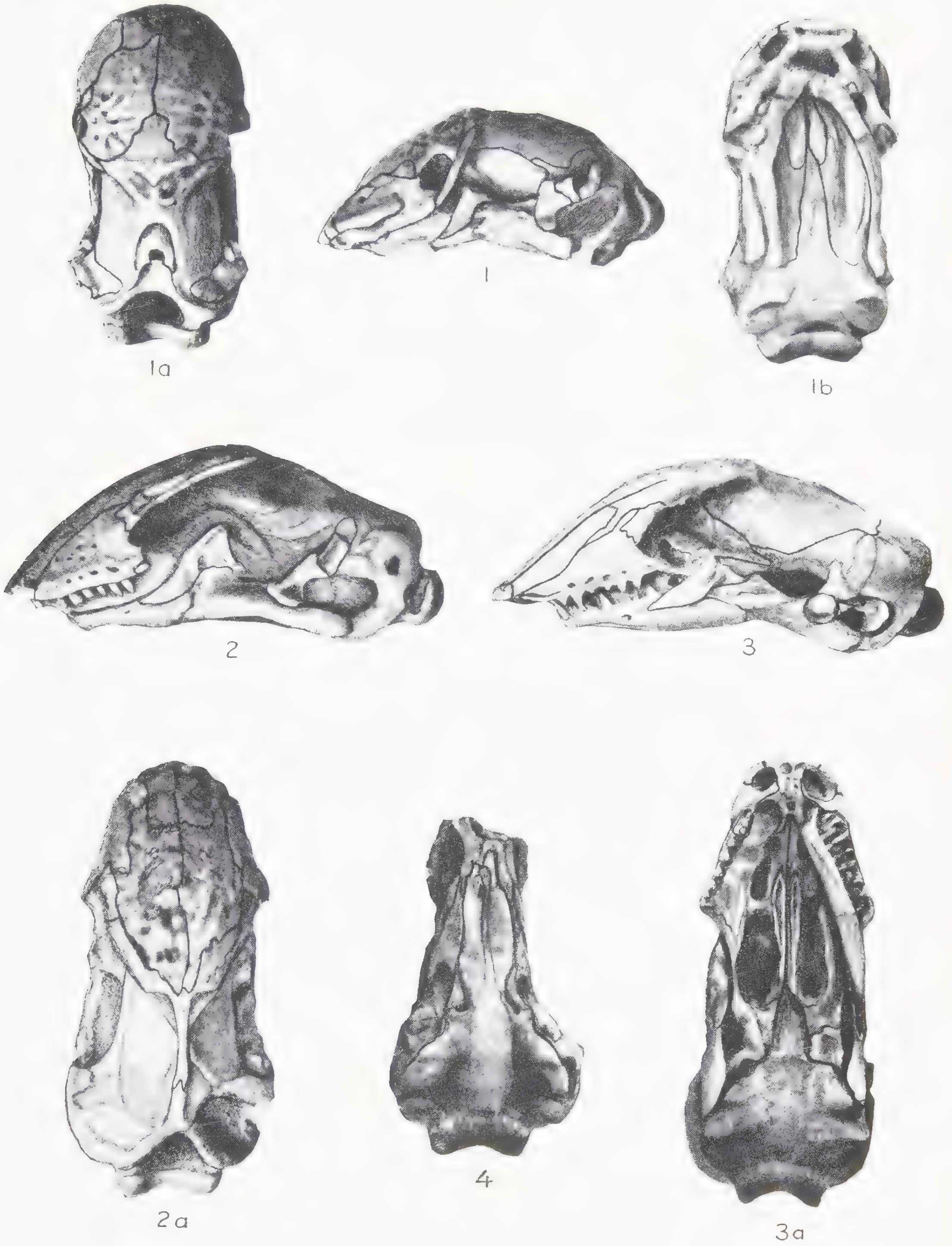
2. *Rhineüra hatcherii* Baur. Type. No. 11389, Princeton Museum. Skull and lower jaws, viewed from the left side. × 5.3.

2a. Same, top view.

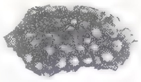
3. *Rhineüra hatcherii* Baur. No. 423a, Carnegie Museum. Skull and lower jaws, viewed from the left side. × 4.5.

3a. Same, ventral view.

4. *Rhineüra hatcherii* Baur. No. 423c, Carnegie Museum. Posterior portion of skull, ventral view showing pterygoids removed. × 4.2.



Skulls of Rhineüra hatcherii Baur and Hyporhina antiqua Baur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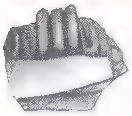
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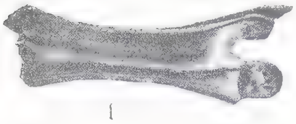
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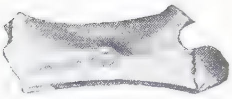
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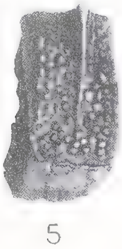
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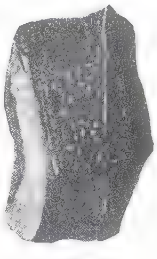
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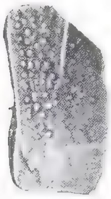
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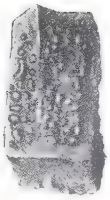
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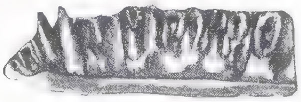
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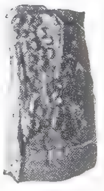
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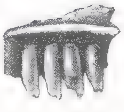
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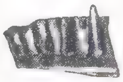
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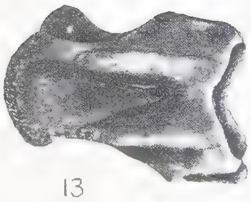
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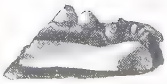
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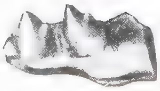
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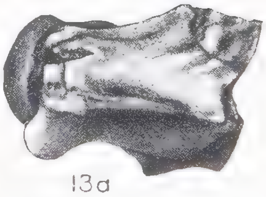
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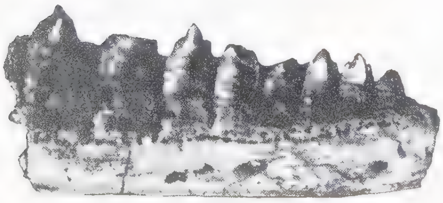
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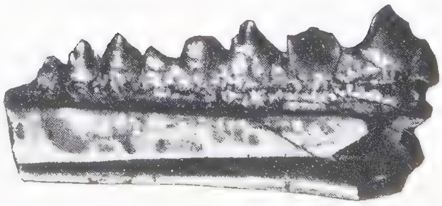
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Iguanavus, Glyptosaurus?, Xestops and Tinosaurus

PLATE 2

FIG. 1. *Iguanavus teres* Marsh. No. 2912, Geol. Surv. Canada. Median caudal vertebra. Viewed from the left side. × 4.

2. *Iguanavus exilis* Marsh. Type. No. 1057, Yale Museum. Anterior caudal vertebra. Viewed from the left side. × 4.

3, 4. *Glyptosaurus? microdus* Marsh. Type. No. 1056, Yale Museum.

3. Fragment of right dentary containing three teeth. Inner view. × 4.5.

4. Head scute found with the type. Dorsal view. × 4.5.

5–10. *Xestops gracilis* (Marsh). Type. No. 1055, Yale Museum.

5–9. Dermal scutes associated with the type; dorsal view. ×4.

10. Anterior portion of right dentary, inner view. × 4.

11, 12. *Xestops minutus* (Marsh). Type. No. 1053, Yale Museum.

11. Fragment of maxillary containing four teeth. Inner view. × 4.

12. Anterior end of dentary containing one complete tooth. Inner view. ×4.

13, 13a. *Xestops lentus* (Marsh). Type. No. 1052, Yale Museum.

13. Caudal vertebra; viewed from below. × 4.

13a. The same, viewed from above.

14. *Tinosaurus stenodon* Marsh. Type of *T. lepidus* Marsh. No. 1053, Yale Museum. Anterior portion of left dentary; inner view. × 4.

15. *Tinosaurus stenodon* Marsh. Type. No. 615, Yale Museum. Median portion of right dentary; inner view. × 4.

16. *Tinosaurus pristinus* (Leidy). Type. No. 9134, Philadelphia Academy of Sciences. Portion of right dentary, viewed from the side. × 5.

16a. The same, inner view.

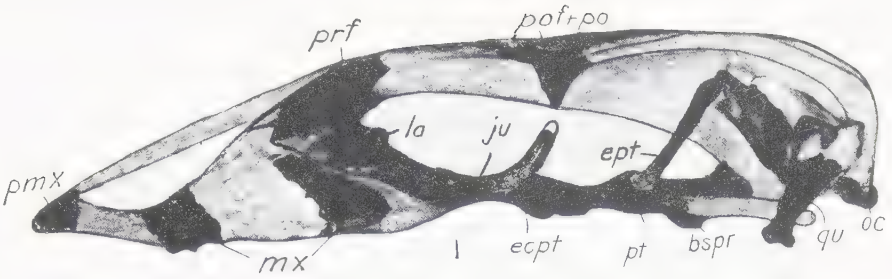
PLATE 3

VARANIDAE

FIG. 1. *Saniwa ensidens* Leidy. Type. No. 2185, U. S. National Museum. Skull, viewed from the left side. About natural size. Shows the original and restored parts.

2. The same, viewed from above.
3. The same viewed from below.

Bs, basisphenoid; *bspr*, basisphenoid process; *ecpt*, ectopterygoid; *ept*, epipterygoid; *exoc*, exoccipital; *ju*, jugal; *la*, lachrymal; *mx*, maxillary; *oc*, occipital condyle; *pl*, palatine; *pmx*, premaxillary; *pof+po*, postfrontal and postorbital; *prf*, prefrontal; *pt*, pterygoid; *qu*, quadrate; *soc*, supraoccipital; *v*, vomer.



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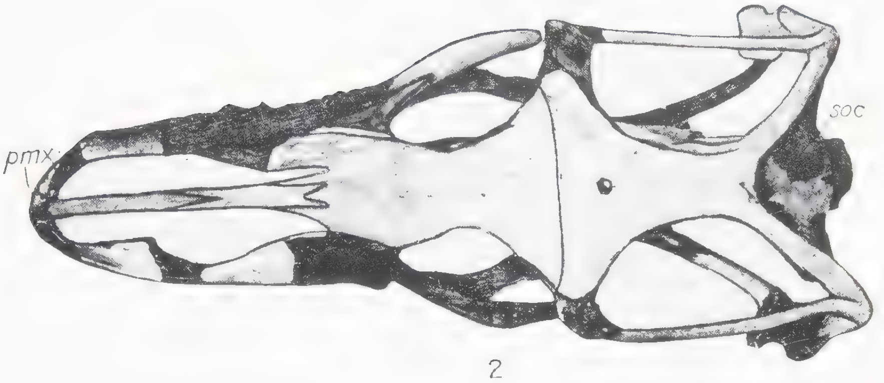

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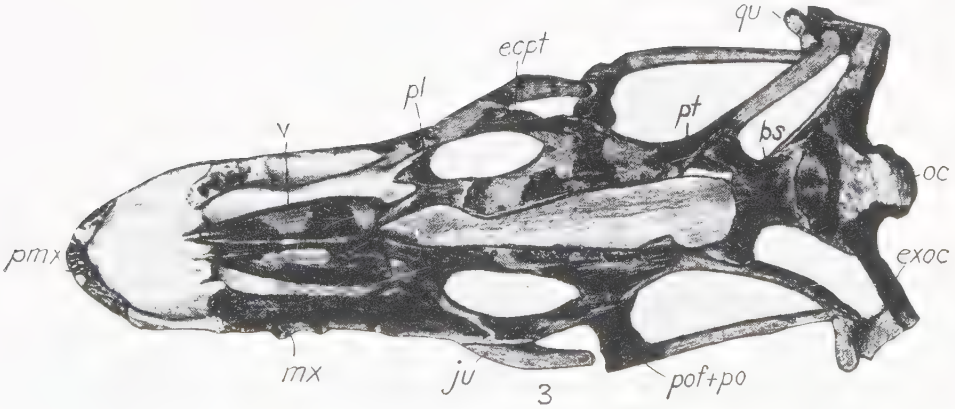

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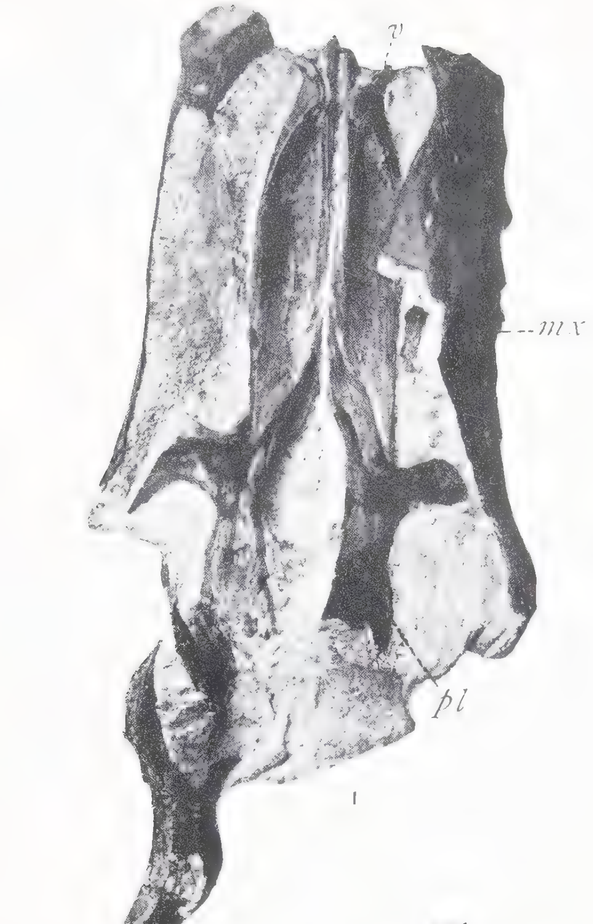
Skull of Saniwa ensidens Leidy



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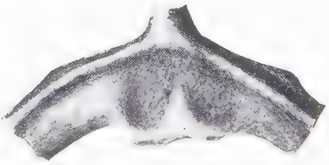

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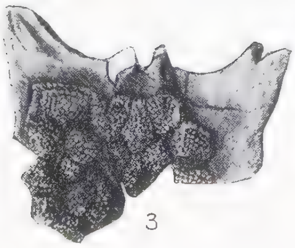

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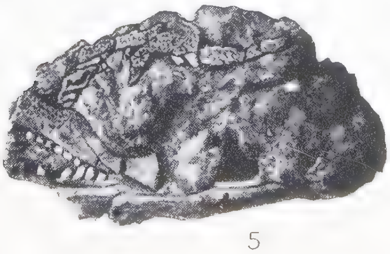

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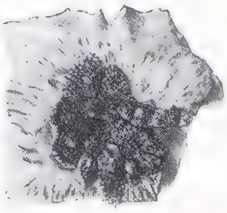


4

Saniwa, Glyptosaurus and Machaeosaurus

PLATE 4

FIG. 1. *Saniwa ensidens* Leidy. Type. No. 2185, U. S. National Museum. Palate, viewed from above. Shown as found articulated in the matrix. × 2.

mx, maxillary; *pl*, palatines; *pt*, pterygoids; *v*, vomers.

2. *Saniwa ensidens* Leidy. Type. No. 2185, U. S. National Museum. Interclavicle, dorsal view. × 4.5.

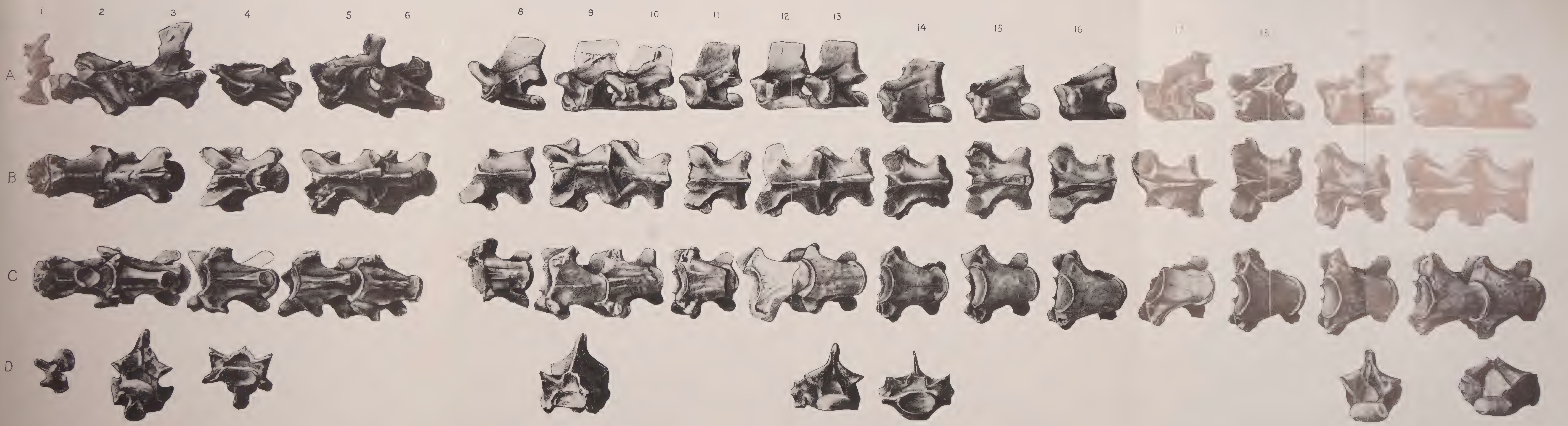
3. *Glyptosaurus hillsi* Gilmore. Paratype. No. 10606, U. S. National Museum. Parietal, viewed from above. Shows median notch on posterior border. About natural size.

4. *Glyptosaurus sylvestris* Marsh. No. 6054, American Museum of Natural History. Parietal, viewed from above. Slightly less than natural size.

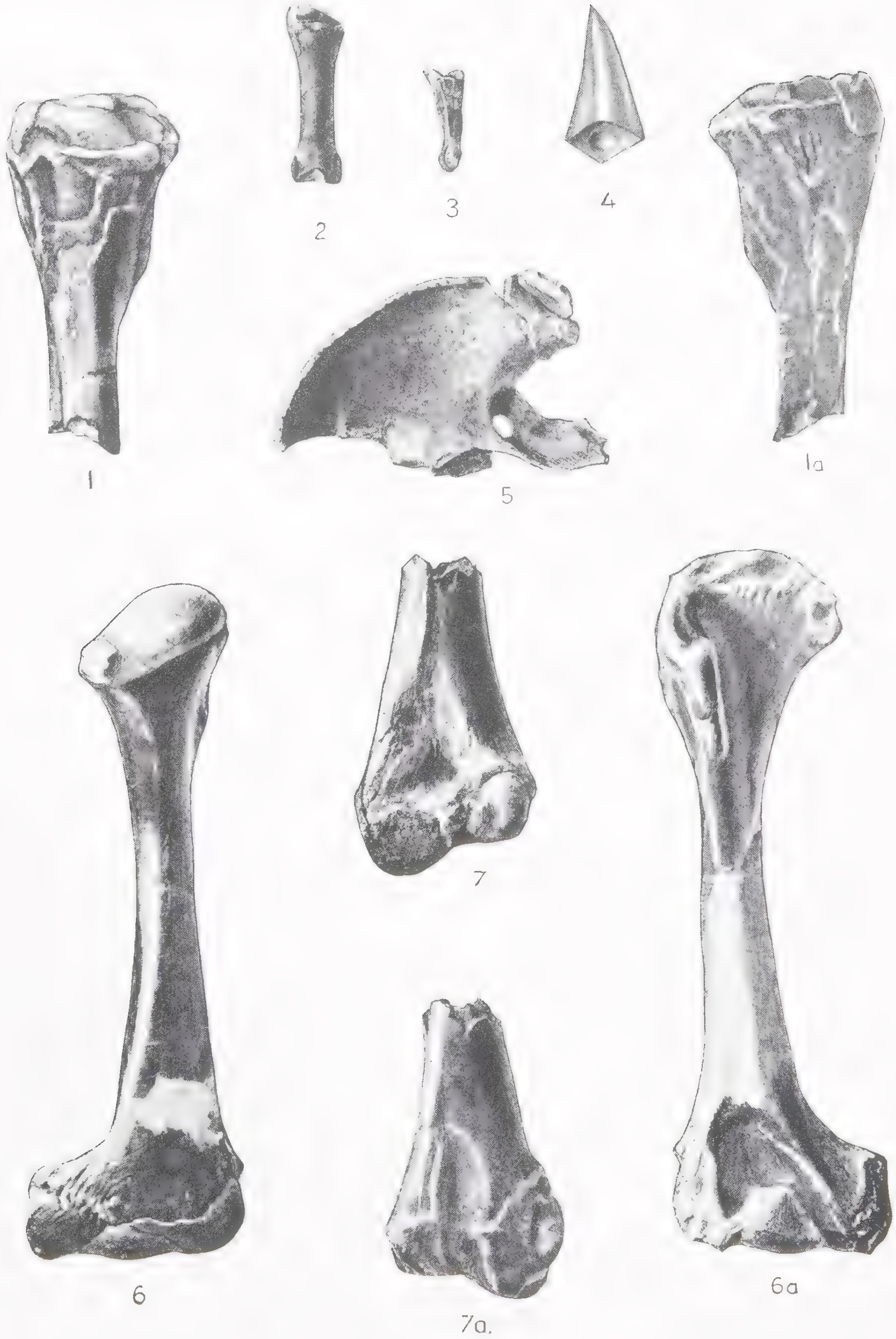
5. *Machaerosaurus torrejonensis* Gilmore. Type. No. 5380, American Museum of Natural History. Skull, viewed from left side. × 2.

PLATE 5

Saniwa ensidens Leidy. Type. No. 2185, U. S. National Museum. Cervical and dorsal vertebrae. × 2. A, lateral view; B, superior view; C, ventral view; D, anterior and posterior views. Numerals 1–21 indicate position in vertebral series enumerated from the atlas. The following series were found articulated: 1 to 6, inclusive; 8 to 11, inclusive; 12 to 21, inclusive.



Vertebrae of Saniwa ensidens Leidy



Saniwa ensidens Leidy

PLATE 6

FIGS. 1–7. *Saniwa ensidens* Leidy. Type. No. 2185, U. S. National Museum.

1. Proximal half of left tibia, front view. × 2.
1a. The same, back view.
2. Proximal phalanx left hind foot, dorsal view. × 2.
3. Distal phalanx of hind foot, side view. × 2.
4. Detached tooth. × 8. (After Leidy.)
5. Coracoid of right side, inner view. × 2.
6. Right humerus, upper view. × 2.
6a. The same, lower view.
7. Distal end of left femur, lower view. × 2.
7a. The same, upper view.

PLATE 7

FIGS. 1–4. *Saniwa ensidens* Leidy. No. 612, Yale Museum. Part of the original type of *Thinosaurus leptodus* Marsh.

1. Right half of pelvic arch, inner view. × 2.

1a. Same, outer view. × 2. *il*, ilium; *is*, ischium; *p*, pubis.

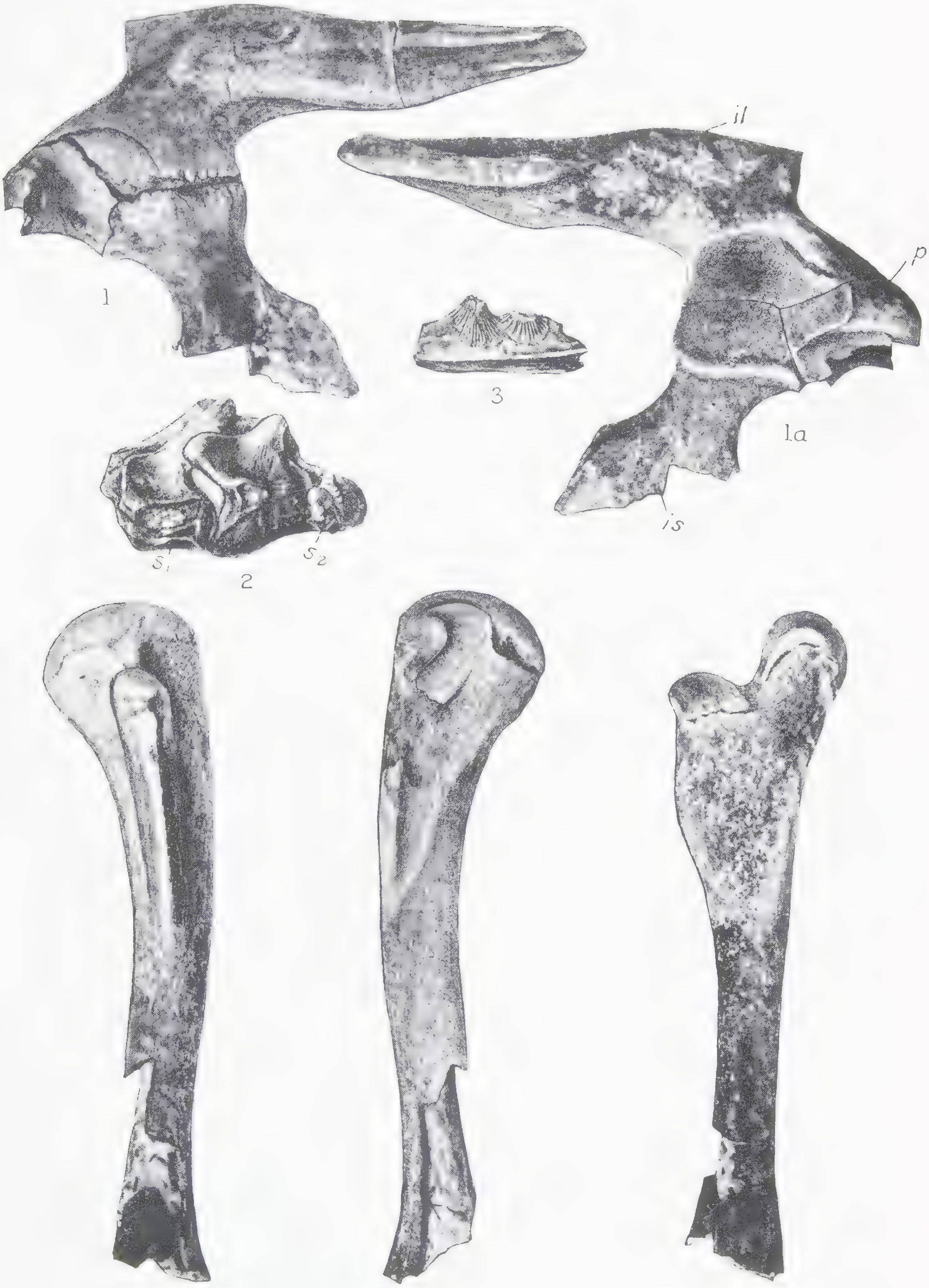
2. Sacral vertebrae, viewed from the left side. × 2. s_1 first sacral; s_2 second sacral.

3. Fragment of right dentary with bases of two teeth. × 2.

4. Left femur, ventral view. × 2.

4a. The same, dorsal view.

4b. The same, anterior view.



Saniwa ensidens Leidy

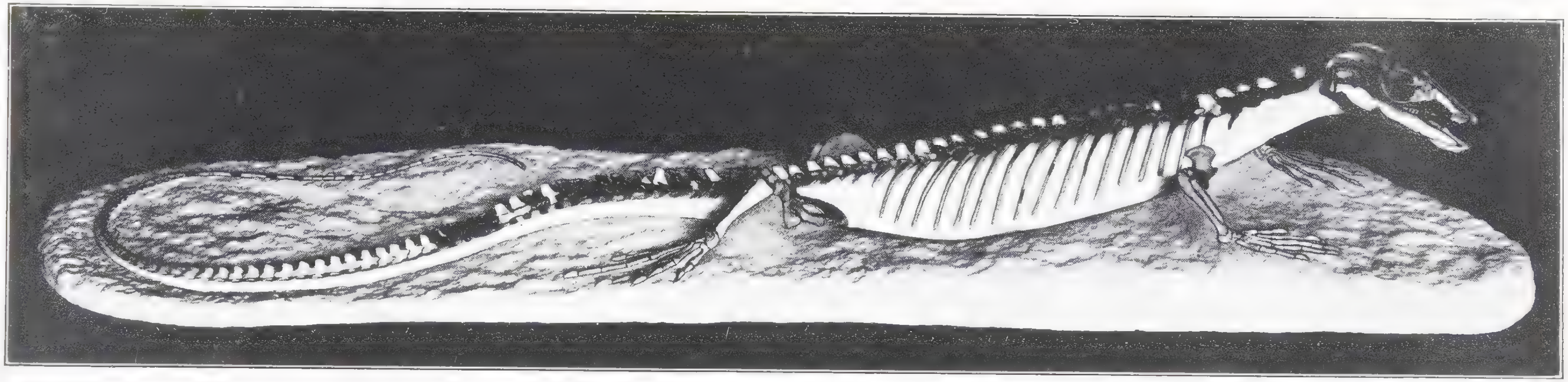


Fig. 1

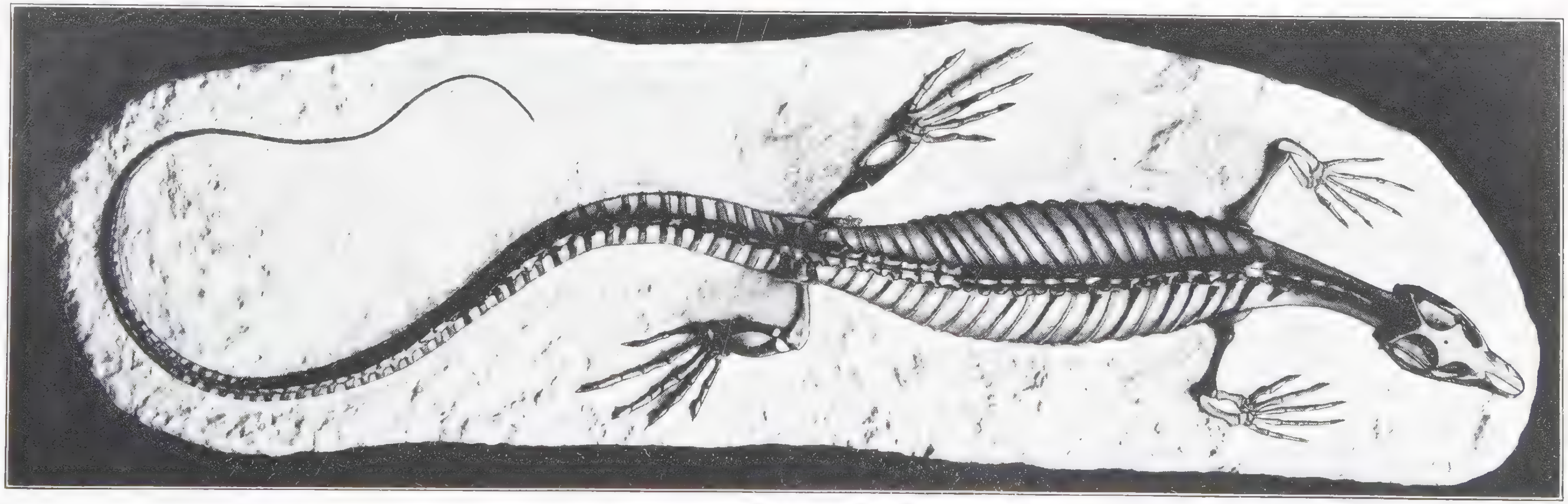


Fig. 2

Restored skeleton of Saniwa ensidens Leidy

PLATE 8

Mounted skeleton of *Saniwa ensidens* Leidy. Type. No. 2185, U. S. National Museum. Shown as mounted for exhibition. The missing parts, when unrepresented among the available fossil materials, were restored after *Varanus*. Restored and mounted by Mr. Norman H. Boss, preparator in the division of vertebrate paleontology, U. S. National Museum.

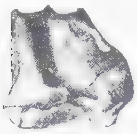
FIG. 1. Viewed obliquely from the right side.
2. Viewed from above.
About × 4½ natural size.

PLATE 9

FIGS. 1–6. *Saniwa agilis* (Marsh). Type. No. 609, Yale Museum.
  1. Distal end of humerus, superior view.
  2. Dorsal vertebra, ventral view.
  3. The same, dorsal view.
  4. The same, lateral view.
  5. Distal end of humerus, ventral view.
  6. Caudal vertebra, ventral view.
    All × 2.

7–9. *Saniwa paucidens* (Marsh). No. 3278, Carnegie Museum.
  7. Articulated dorsal vertebrae, lateral view, left side.
  8. Posterior dorsal vertebrae, ventral view.
  9. Posterior dorsal vertebrae, dorsal view.
    All × 2.

10–12. *Saniwa ensidens* Leidy.
  10. Ischium, lateral view. No. 1070, Yale Museum.
  11. Parietal, dorsal view. No. 1074, Yale Museum.
  12. Calcaneum, lateral view. No. 613, Yale Museum.
    All × 2.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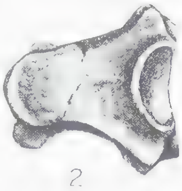
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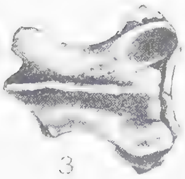
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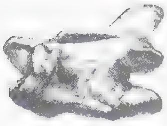
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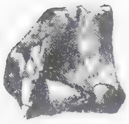
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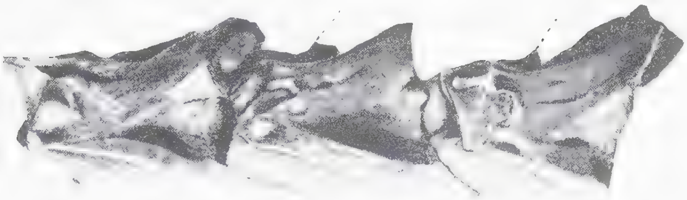

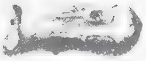
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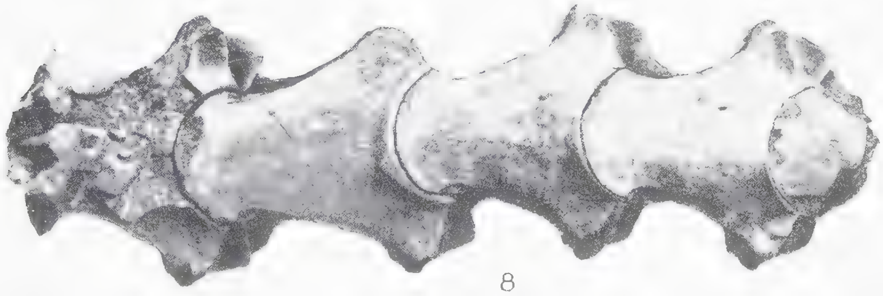
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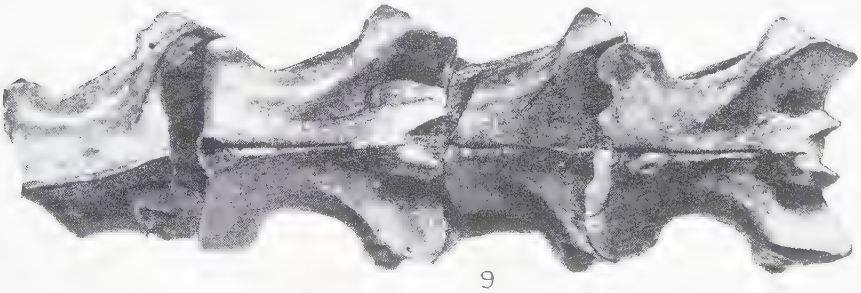
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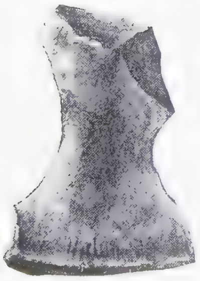
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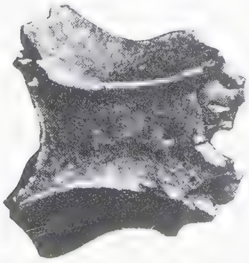
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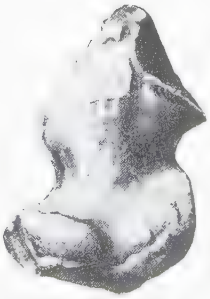
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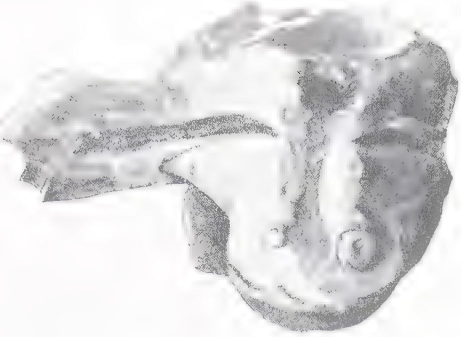
Saniwa agilis (Marsh), Saniwa paucidens (Marsh) and Saniwa ensidens Leidy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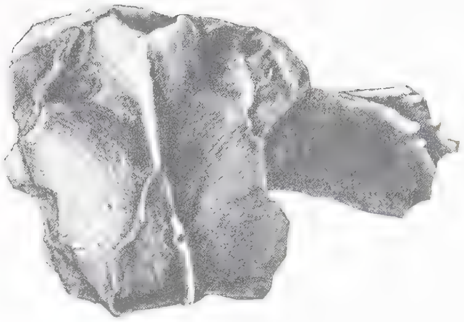
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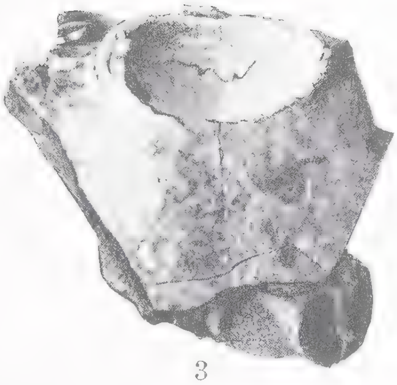
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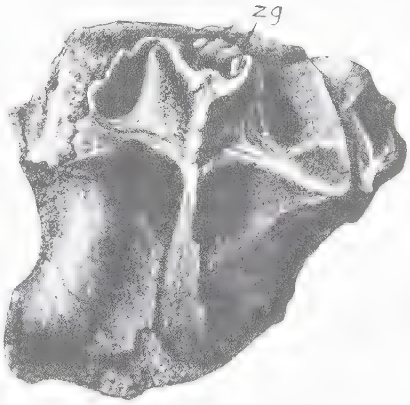

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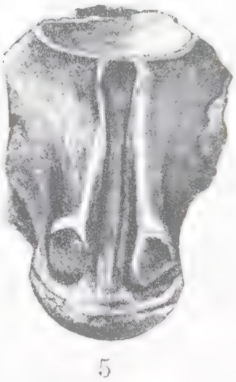
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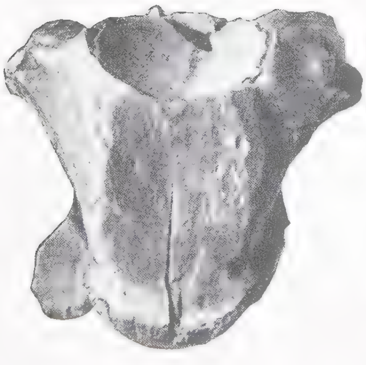
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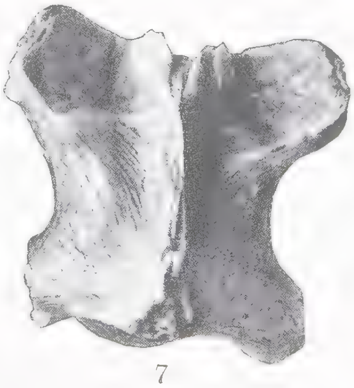
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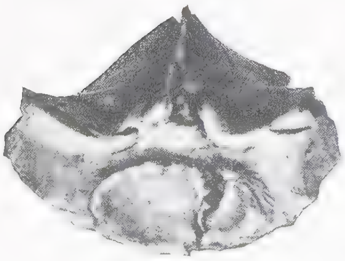
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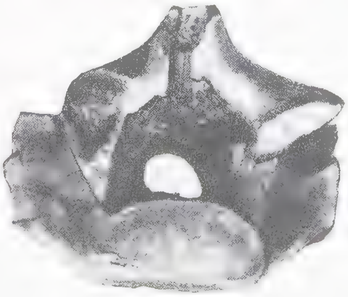
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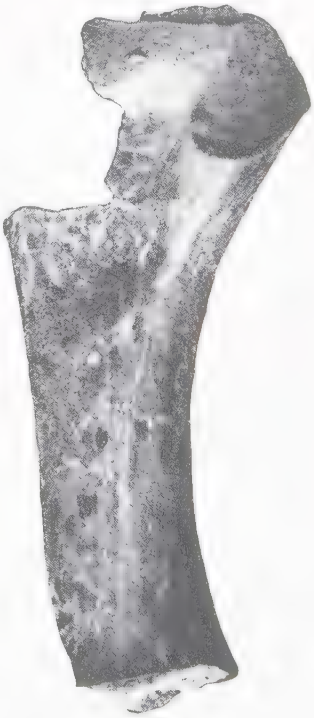
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Saniwa grandis (Marsh) and Saniwa crassa (Marsh)

PLATE 10

FIGS. 1–5. *Saniwa grandis* (Marsh). Type. No. 611, Yale Museum.
1. First caudal vertebra, ventral view.
2. Same, dorsal view.
3. Dorsal vertebra, ventral view.
4. Same, dorsal view, showing infolded zygosphene (*zg*).
5. Anterior caudal vertebra, ventral view.

All × 2.

6–10. *Saniwa crassus* (Marsh). Type. No. 610, Yale Museum.
6. Dorsal vertebra, ventral view.
7. Same, dorsal view.
8. Dorsal vertebra, anterior view.
9. Dorsal vertebra, posterior view.
10. Portion of left humerus, ventral view.

All × 2.

PLATE 11

FIG. 1. *Heloderma matthewi* Gilmore. Type. No. 990a, American Museum of Natural History. Left maxillary, posterior part, outer view. × 4.

1a. The same, inner view.

2. *Saniwa major* Leidy. Type. Philadelphia Academy of Natural Sciences. Two articulated dorsal vertebrae, ventral view. Natural size.

2a. The same, lateral view, right side.
(After Leidy.)

3. *Glyptosaurus* sp. No. 5109. American Museum of Natural History. Premaxillary, viewed from the front. × 2.

4, 4a, 4b. Lacertilian vertebra from the Cretaceous? of New Jersey. No. 1309, American Museum of Natural History.

4. Dorsal view.

4a. Ventral view.

4b. Lateral view, right side.
All × 2.

5, 5a, 5b. *Palæosaniwa canadensis* Gilmore. Type. No. 10864, U. S. National Museum.

5. Dorsal vertebra, lateral view, left side.

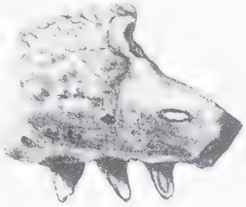
5a. Same, ventral view.

5b. Same, dorsal view.
All × 2.

6. *Palæosaniwa canadensis* Gilmore. No. 112, University of Alberta. Dorsal vertebra, ventral view. × 2.

6a. The same, dorsal view.

7. *Peltosaurus* sp. No. 11392, Princeton Museum. Dorsal vertebra, ventral view. × 4.



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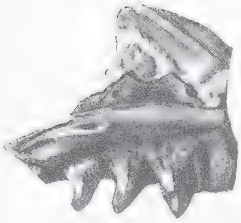

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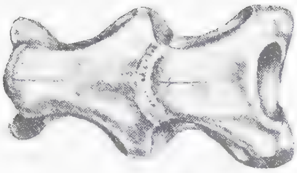

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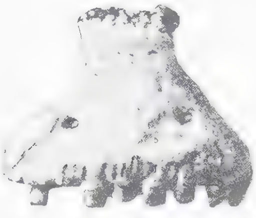

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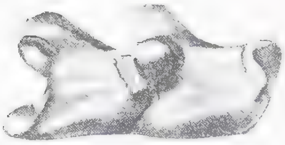

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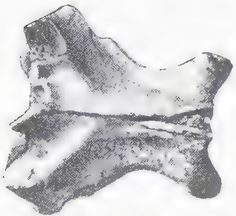

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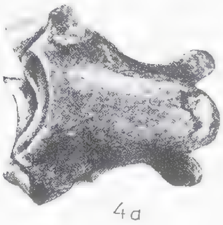

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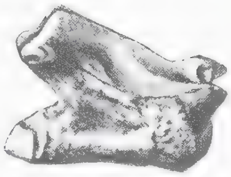

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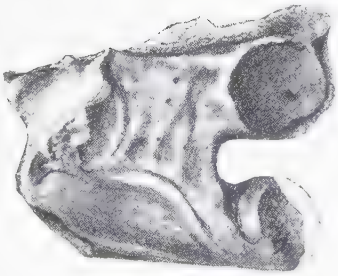

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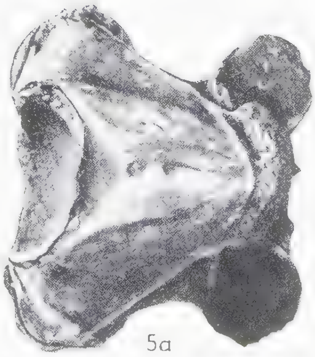

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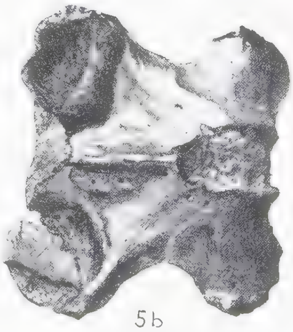

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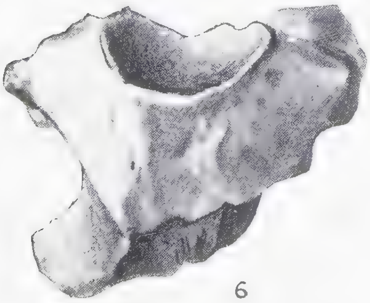

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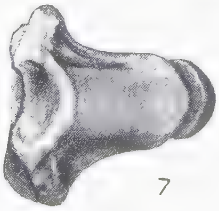

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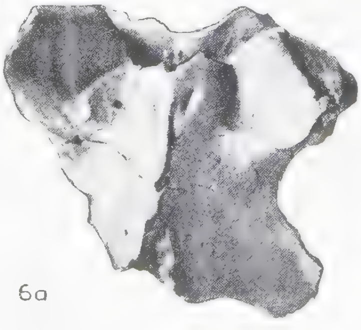

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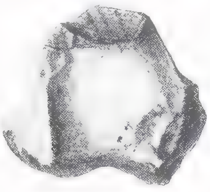
Heloderma, Saniwa, Glyptosaurus, Palæosaniwa, and Peltosaurus



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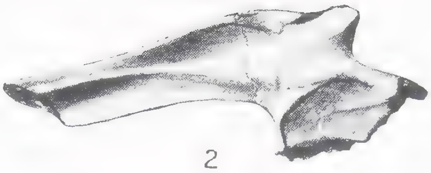

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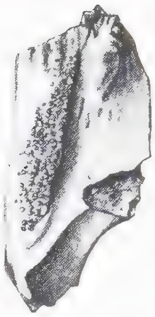

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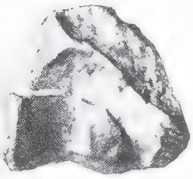

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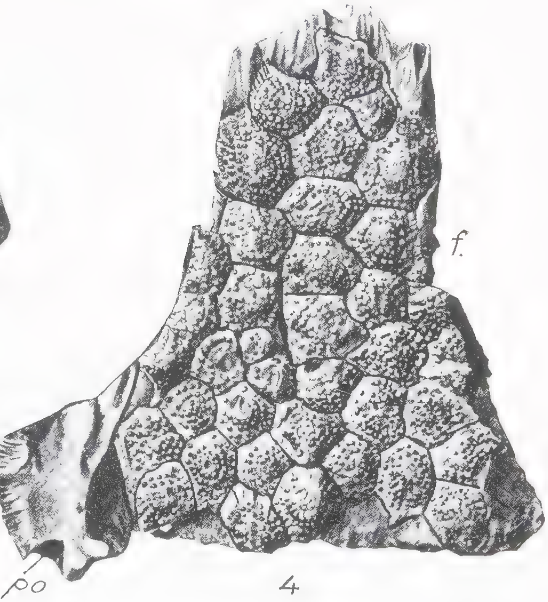

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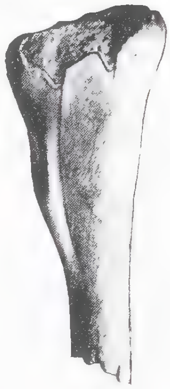

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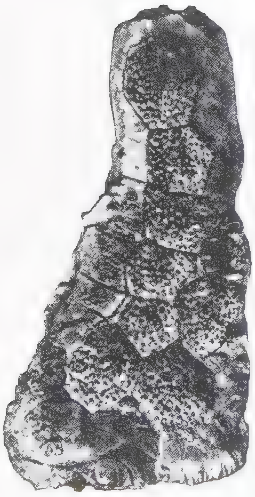

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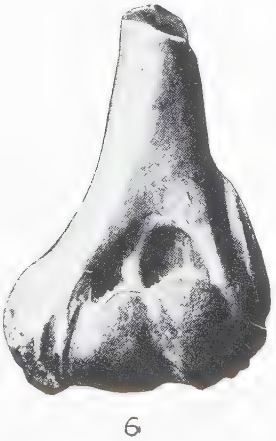

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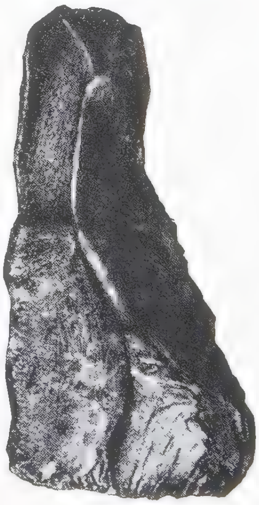


7a

Glyptosaurus sylvestris Marsh

PLATE 12

Figs. 1–6. *Glyptosaurus sylvestris* Marsh. No. 1072, Yale Museum.

1. Distal end of left femur, dorsal view.

1a. The same, ventral view.

2. Right ilium, lateral view.

3. Portion of left pterygoid, ventral view.

4. Left postfrontal and frontals covered with osseous scutes, dorsal view. *f*, frontal; *pof*, post-frontal; *po*, cup for articulation of anterior end of postorbital.

5. Proximal half of left tibia, lateral view.

6. Distal portion of left humerus, ventral view.

All × 2.

7. *Glyptosaurus sylvestris* Marsh. Type. No. 526, Yale Museum. Left frontal, dorsal view. × 2.

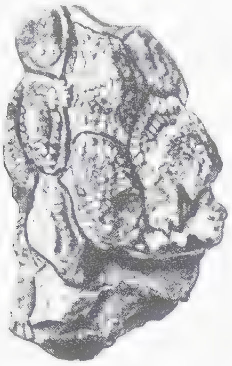
7a. The same, inferior view.

PLATE 13

FIGS. 1–9. *Glyptosaurus sylvestris* Marsh. No. 521, Yale Museum. All except 4 and 4a are part of the original type of *G. brevidens* Marsh.

1 Scutes from the head, dorsal view.
2. Anterior portion of frontal bones, dorsal view.
3. Portion of left frontal articulated with postfrontal and upper extremity of jugal; side view. *f*, frontal; *ju*, jugal; *ptf*, postfrontal.
4. Group of head scutes. (Type of *G. ocellatus* Marsh. No. 523, Yale Museum.) Ventral view.
4a. The same, dorsal view.
5. Articulated body scutes, dorsal view.
6. Articulated head scutes, dorsal view.
7. Group of articulated body scutes.
8. Portion of left jugal articulated with posterior end of maxillary containing four teeth; inner view. *ju*, jugal; *mx*, maxillary.
9. Group of articulated head scutes, dorsal view.

All × 2.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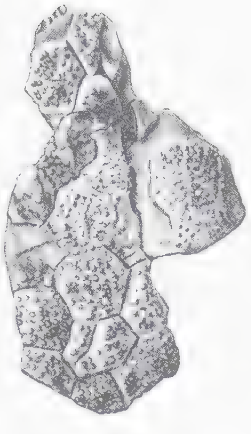
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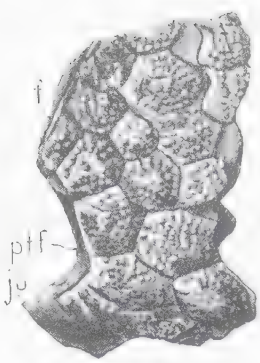

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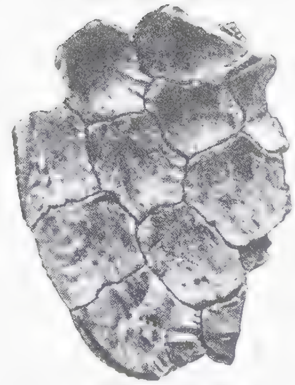
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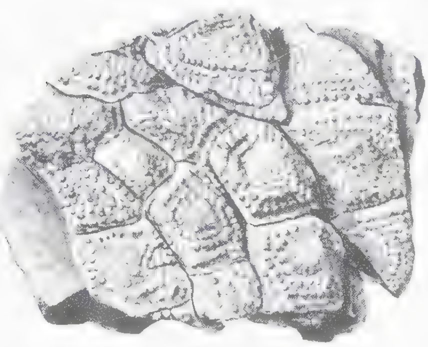
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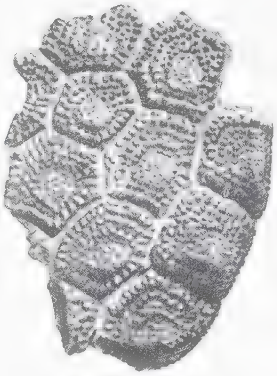
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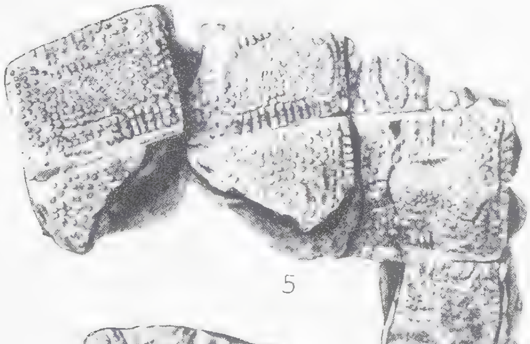
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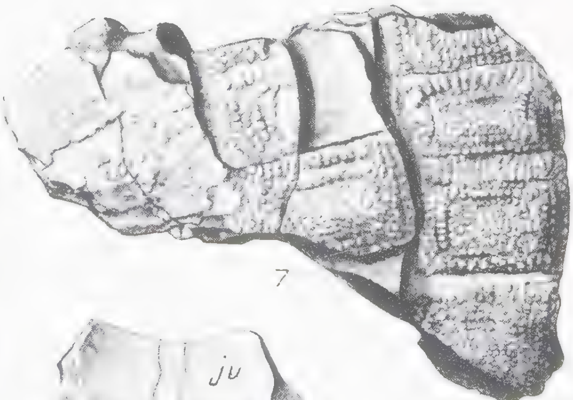
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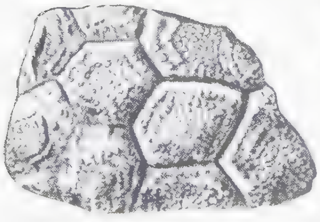
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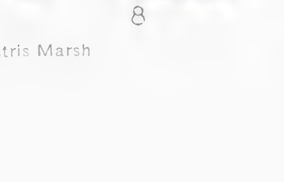

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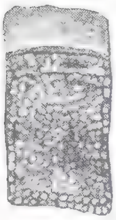
Glyptosaurus sylvestris Marsh



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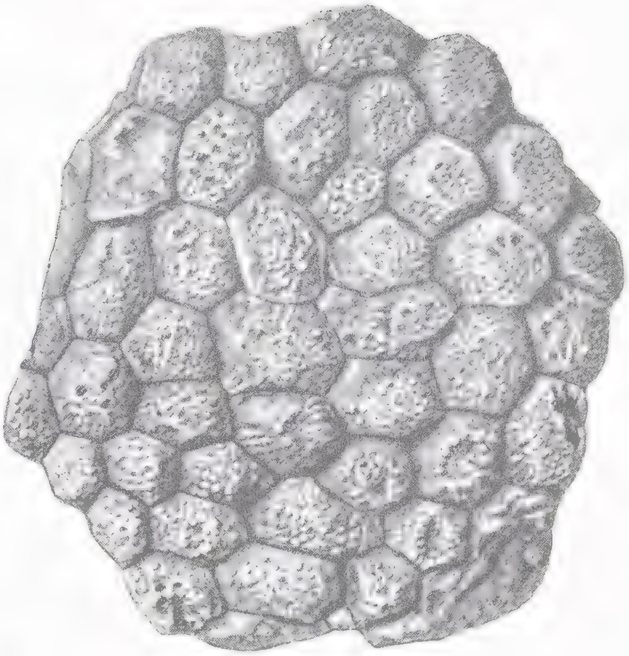

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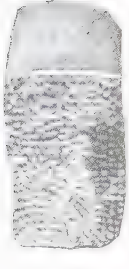

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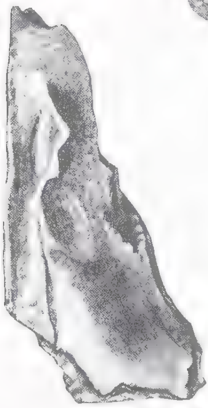

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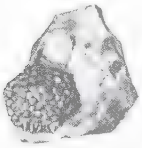

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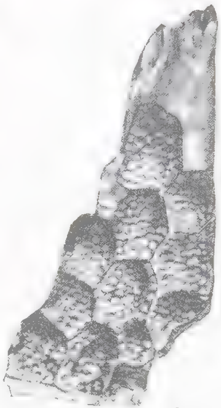

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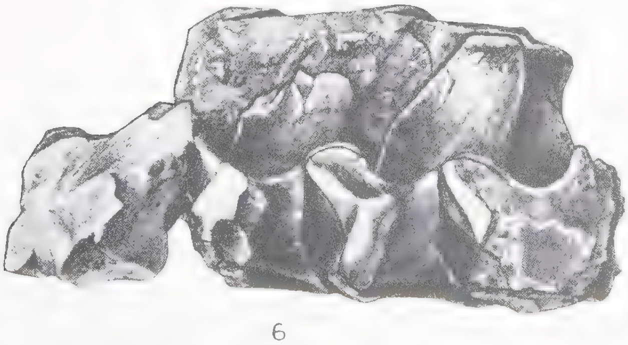

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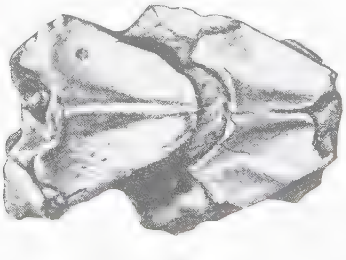

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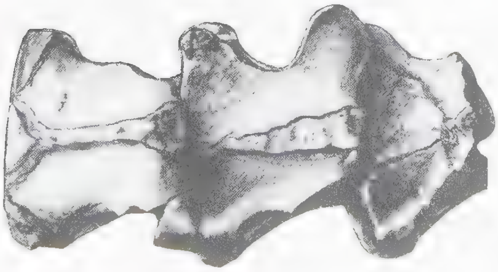

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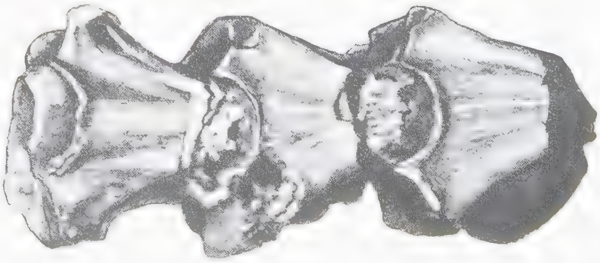


9

Glyptosaurus giganteus Gilmore, G. nodosus Marsh and G. sylvestris Marsh

PLATE 14

Fig. 1. *Glyptosaurus giganteus* Gilmore. Type. No. 1471, Carnegie Museum. Median portion of frontals, dorsal view. × 2.

2–5. *Glyptosaurus nodosus* Marsh. Type. No. 522, Yale Museum.
2. Dermal scute showing short imbrication, dorsal view.
3. Dermal scute showing long imbrication, dorsal view.
4. Left frontal, ventral view.
4a. The same, dorsal view.
5. Head scute attached to fragment of skull, dorsal view.
All × 2.

6–9. *Glyptosaurus sylvestris* Marsh. No. 521, Yale Museum. Part of the type of *G. brevidens* Marsh.
6. Median dorsal vertebra, side view.
7. Anterior dorsal vertebra, ventral view.
8. Median dorsal vertebra, dorsal view.
9. Dorsal vertebra, ventral view.
All × 2.

PLATE 15

FIGS. 1, 3–5. *Glyptosaurus princeps* Marsh. No. 5113, American Museum of Natural History.

1. *Glyptosaurus princeps* Marsh. Posterior portion of left dentary, outer view.
2. *Melanosaurus maximus* Gilmore. Type. No. 5168, American Museum of Natural History. Posterior portion of right dentary, inner view. × 2.
3. *Glyptosaurus princeps* Marsh. Right maxillary, inner view.
4. *Glyptosaurus princeps* Marsh. Pterygoid; teeth somewhat obscured by incrusted matrix; ventral view.
5. *Glyptosaurus princeps* Marsh. Left prefrontal and frontals, dorsal view.

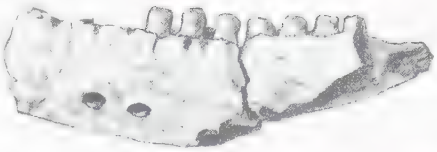
All × 2.

6. *Glyptosaurus* cf. *obtusidens* Loomis. No. 5181, American Museum of Natural History. Frontals, dorsal view. × 2.

FIGS. 7, 7a, 8. *Glyptosaurus princeps* Marsh. Type. No. 524, Yale Museum.

7. Frontals, ventral view.
7a. The same, dorsal view.
8. Pterygoid showing extent of teeth, ventral view.

All × 2.



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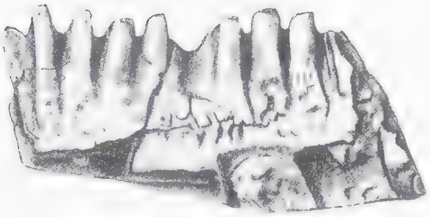

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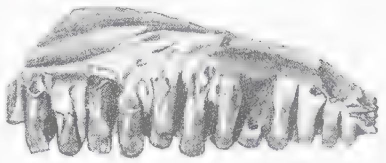

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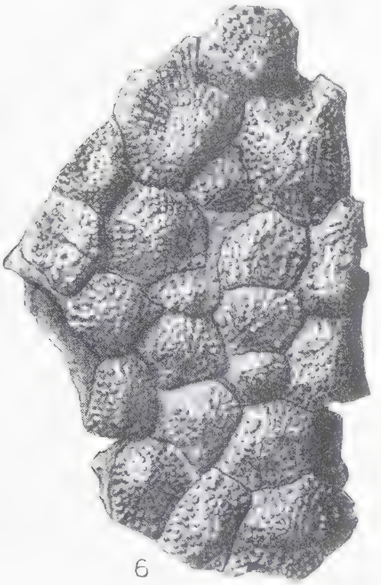

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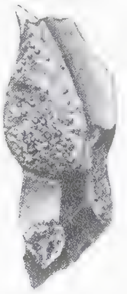

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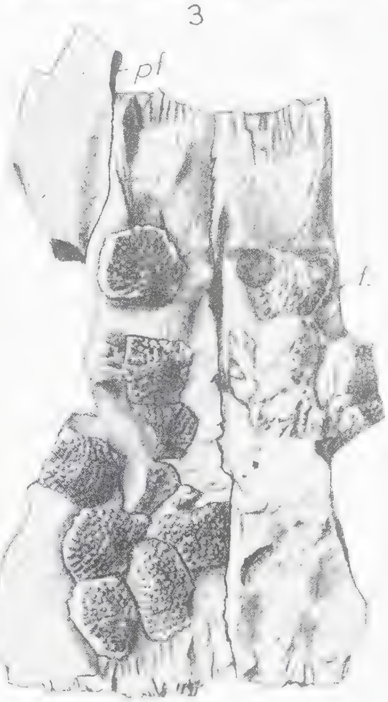

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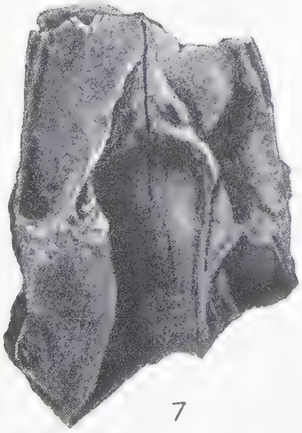

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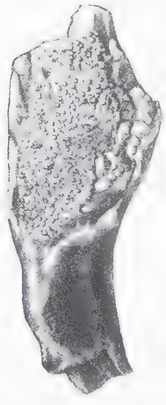

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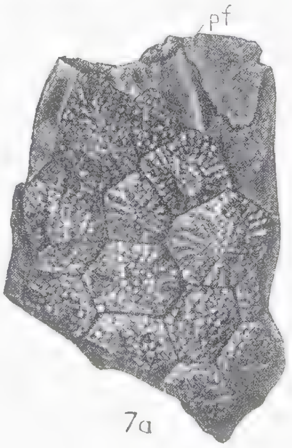
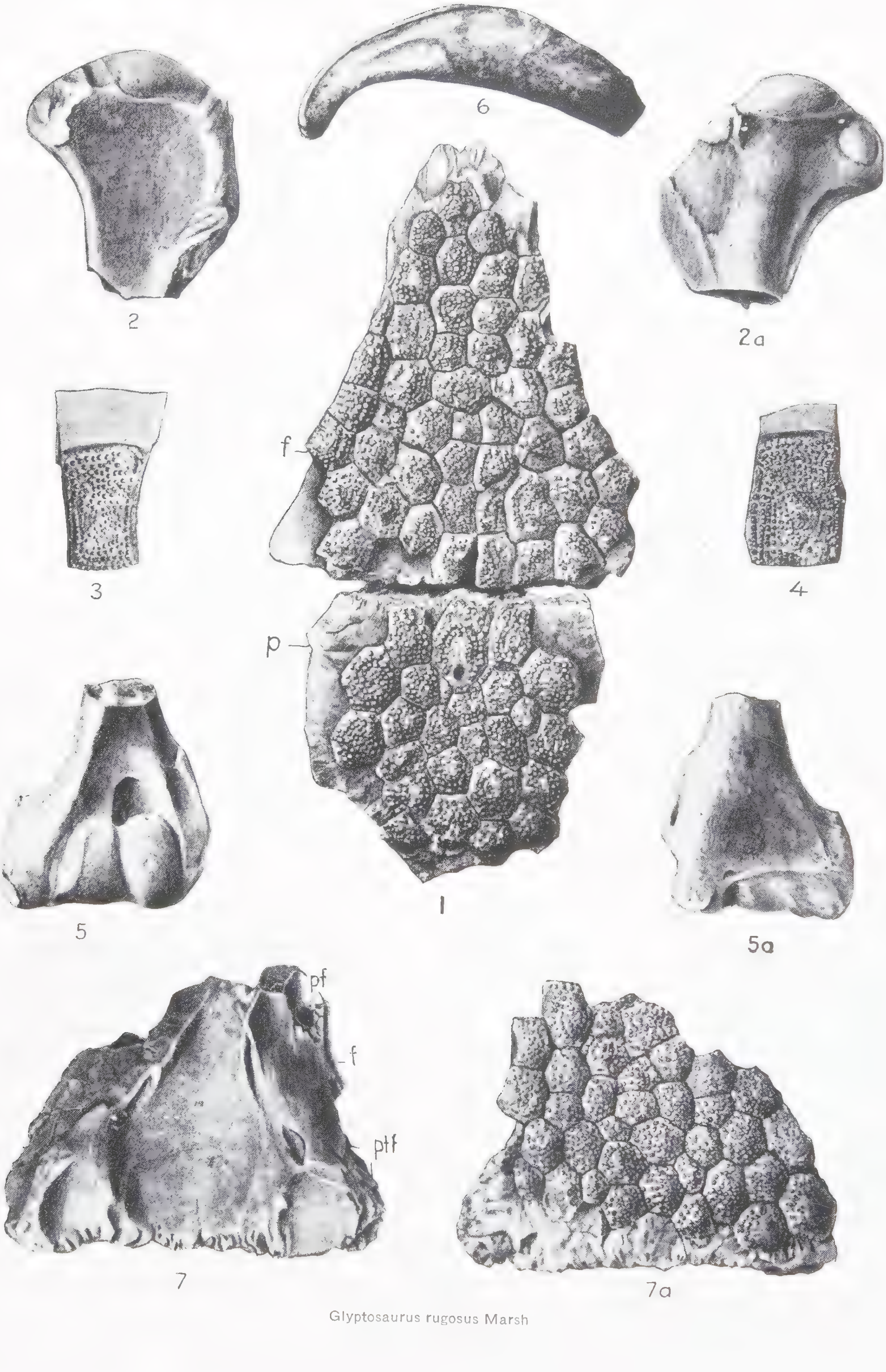


7a

Glyptosaurus and Melanosaurus



Glyptosaurus rugosus Marsh

PLATE 16

FIGS. 1–6. *Glyptosaurus rugosus* Marsh. No. 6055, American Museum of Natural History.

1. Frontal and parietal bones showing scutes on dorsal surface. *f*, frontal; *p*, parietal.
2. Proximal end of left humerus. Viewed from below.

2a. Same, viewed from above.

3. Body scute, dorsal view, showing long imbrication.
4. Body scute, dorsal view, showing short imbrication.
5. Distal end of left humerus viewed from below.

5a. Same, viewed from above.

6. Left squamosal, side view.

All × 2.

7. *Glyptosaurus rugosus* Marsh. Type. No. 525, Yale Museum. Posterior half of coossified frontals, ventral view. *f*, frontal; *pf*, surface for articulation of prefrontal; *ptf*, surface for articulation of postfrontal. × 2.

7a. Same, dorsal view.

PLATE 17

FIGS. 1–4. *Glyptosaurus hillsi* Gilmore. Type. No. 6004, U. S. National Museum.

1. Right ramus, inner view. *an*, angular; *ar*, articular; *co*, coronoid; *d*, dentary; *par*, prearticular; *s*, splenial; *sa*, surangular.

1a. The same, outer view.

2. Skull, dorsal view. *f*, frontal; *n*, nasal; *p*, parietal; *ptf*, postfrontal.

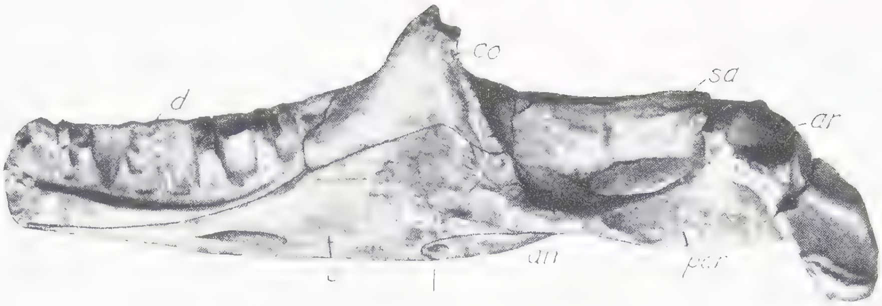
3. Median dorsal vertebra. Ventral view.

3a. The same, viewed from left side.

4. Fragmentary portion of right jugal and maxillary bones, lateral view. *ju*, jugal; *mx*, maxillary.

4a. Fragmentary portion of left jugal, inner view. *ju*, jugal; *mx*, maxillary.

All figures about natural size.



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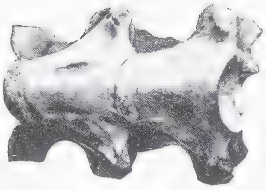

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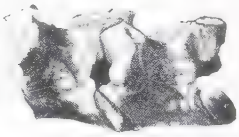

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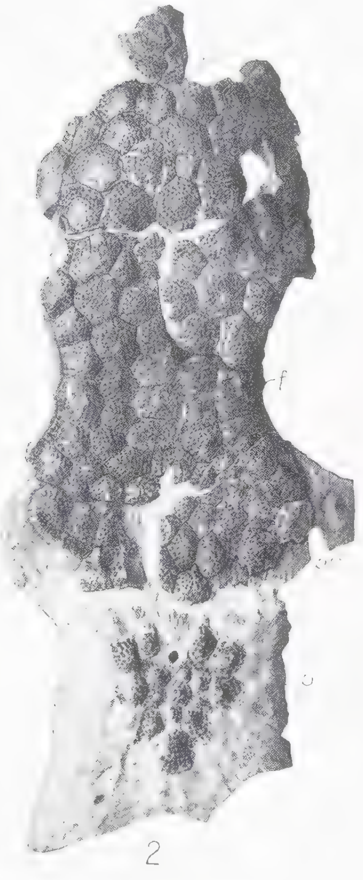

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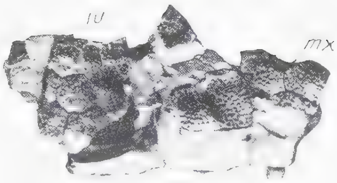

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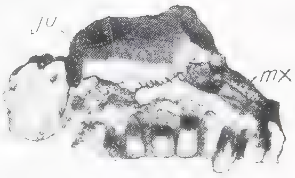

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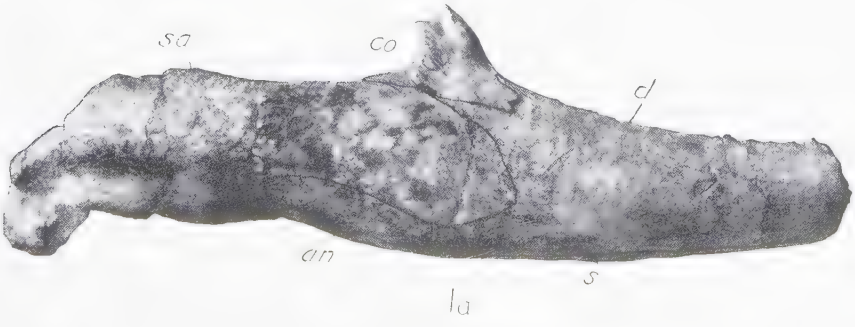
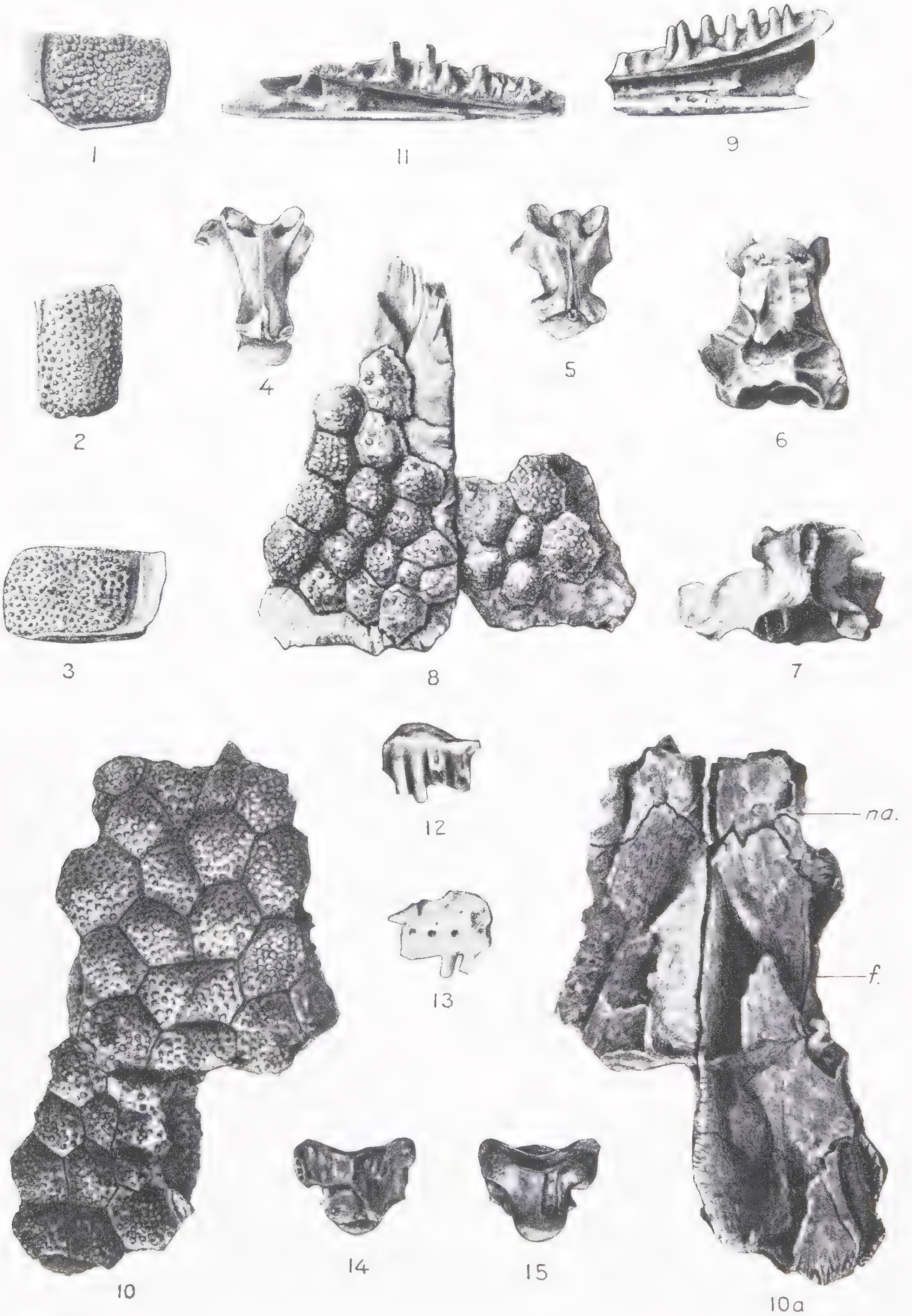


1a

Glyptosaurus hillsi Gilmore



Glyptosaurus tuberculatus (Douglass), G. sphenodon Marsh and Ototriton anceps (Marsh)

PLATE 18

FIGS. 1-9. *Glyptosaurus tuberculatus* (Douglass). No. 1611, American Museum of Natural History.

1, 2, 3. Body scutes.

4, 5. Median caudal vertebrae, dorsal view.

6. Anterior caudal vertebra, ventral view.

7. Sacral vertebra, dorsal view.

8. Frontals, dorsal view.

9. Posterior portion of right dentary with teeth, inner view.

All × 2.

FIGS. 10–11. *Gylptosaurus tuberculatus* (Douglass). Type. No. 707, Carnegie Museum.

10. Frontals articulated with posterior ends of nasals, dorsal view.

10a. Same, ventral view. *f*, frontals; *na*, nasals.

11. Left dentary, inner view.

All × 2.

12. *Glyptosaurus sphenodon* Marsh. Type. No. 1051, Yale Museum. Fragment of maxillary with teeth, inner view. × 2.

13. The same, outer view.

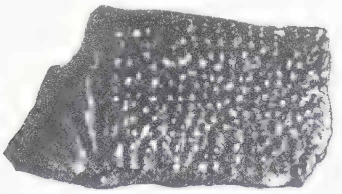
14. *Ototriton anceps* (Marsh). Type of *Glyptosaurus anceps*. No. 520, Yale Museum. Dorsal vertebra, dorsal view. × 2.

15. The same, ventral view.

PLATE 19

Fig. 1. *Glyptosaurus obtusidens* Loomis. Paratype. No. 106, Amherst College. Dermal scute, outer view. ×5.
2. *Glyptosaurus obtusidens* Loomis. Type. No. 133, Amherst College. Portion of left dentary containing teeth, inner view. × 5.
3-11. *Xestops vagans* (Marsh). Type. No. 541, Yale Museum.
3. Frontals, dorsal view.
4-9. Dermal scutes, dorsal view.
10. Fragment of pterygoid showing tooth patch, ventral view.
11. Portion of left dentary, inner view.
All × 2.

Plate XIX



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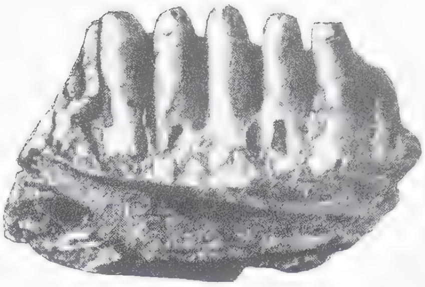

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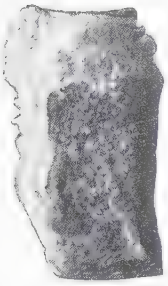

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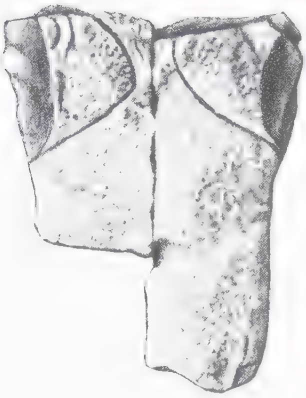

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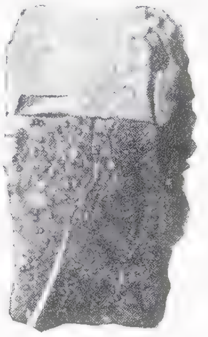

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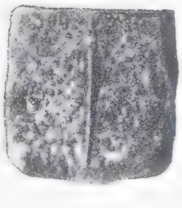

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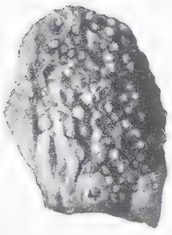

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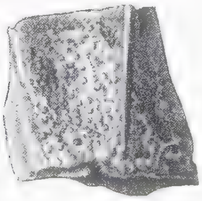

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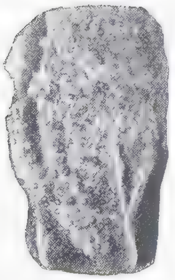

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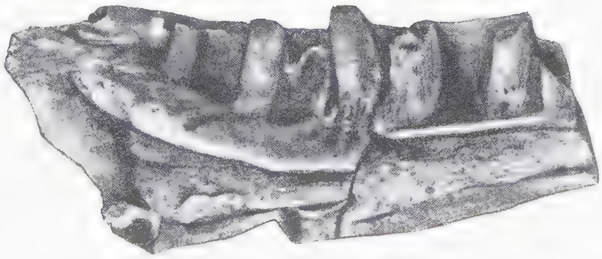

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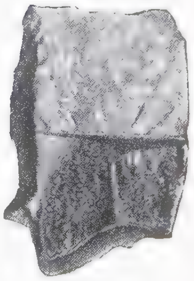

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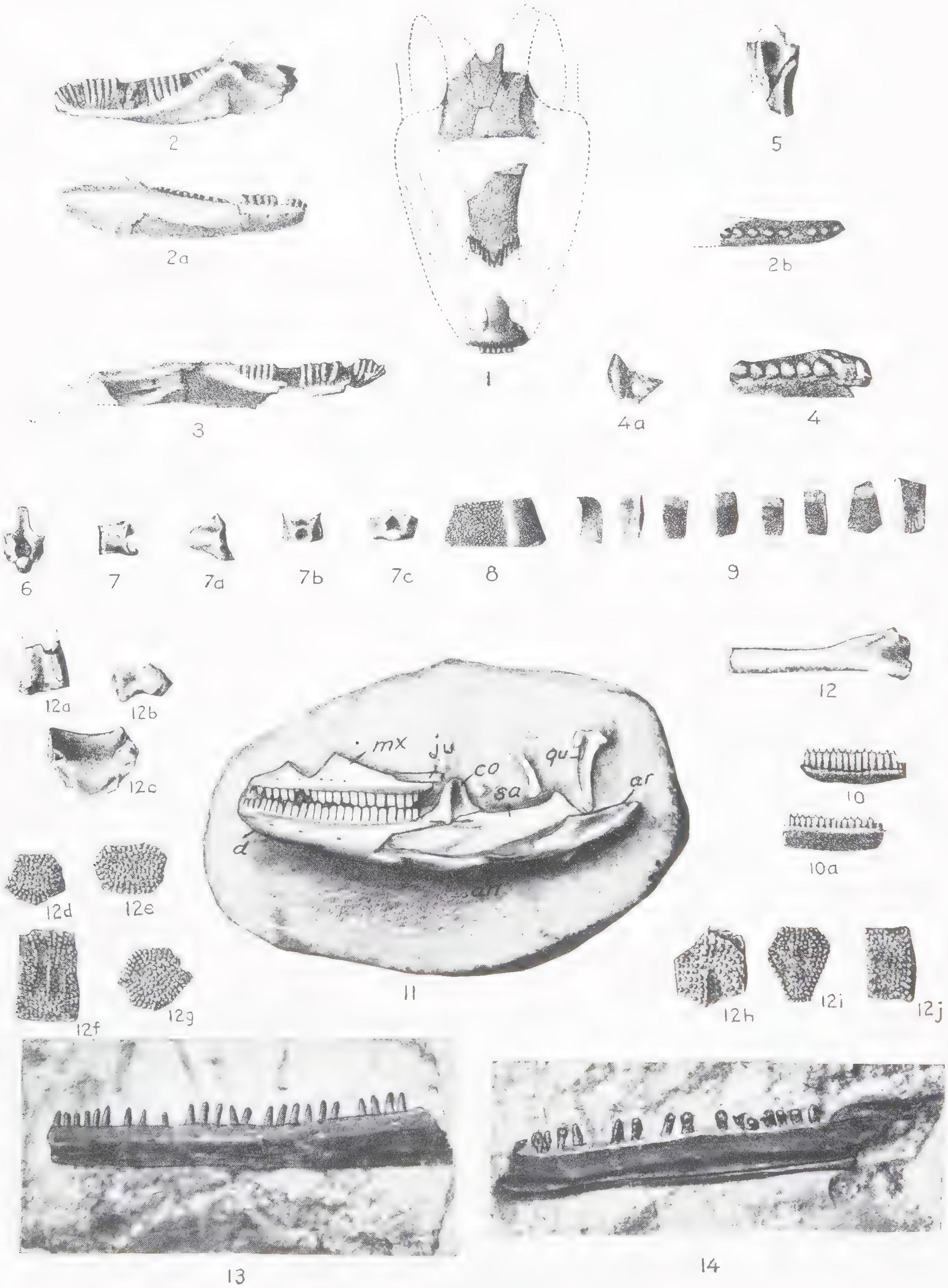
Glyptosaurus obtusidens Loomis and Xestops vagans (Marsh)



Peltosaurus, Aciprion, Glyptosaurus, and Cteniogenys

PLATE 20

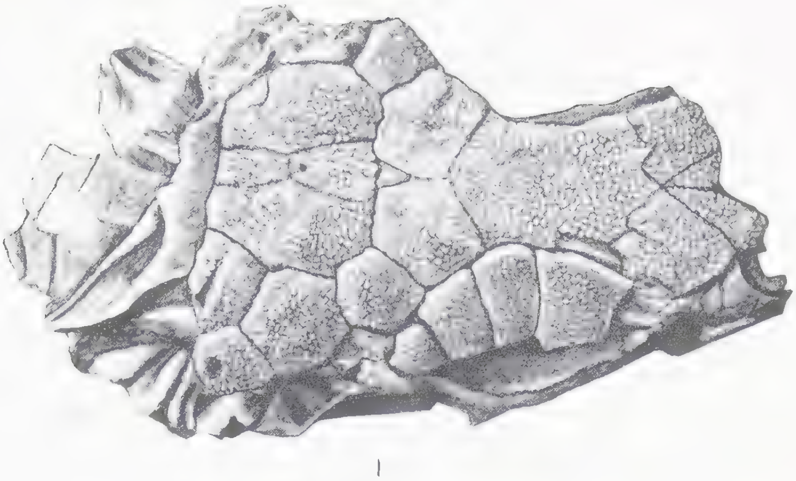
FIGS. 1–9. *Peltosaurus granulosus* Cope. Type. No. 1610, American Museum of Natural History. (All after Cope.)

1. Cranium, restored in outline, showing dorsal view of parietal, frontal, and premaxillary. Natural size.
2. Right ramus lacking posterior third, inner view. Natural size.
2a. The same, outer view. Natural size.
2b. The same, showing crowns of teeth of anterior part of dentary bone. × 2.
3. Left ramus, inner view. Natural size.
4. Maxillary teeth, from below. × 2.
4a. The same, end view. × 2.
5. Frontal bone, ventral view. Natural size.
6. Anterior vertebra, posterior view. Natural size.
7. Dorsal vertebra, side view. Natural size.
7a. The same, ventral view. Natural size.
7b. The same, anterior view. Natural size.
7c. The same, posterior view. Natural size.
8. Dermal scute of body, dorsal view. × 2.
9. Dermal scutes of body; the smooth ones are seen from below, others showing upper sculptured surfaces. Natural size.
10. *Aciprion formosum* Cope. Type. No. 1609, American Museum of Natural History. Dentary, with teeth. Inner view. × 2.
10a. The same, outer view. × 2.
(Both after Cope.)
11. *Aciprion majus* Gilmore. Type. No. 10015, Princeton Museum. Left lower jaw. Lateral view from the left side. *an*, angular; *ar*, articular; *co*, coronoid; *d*, dentary; *ju*, jugal; *mx*, maxillary; *qu*, quadrate; *sa*, surangular. × 2.5.
12–12j. *Glyptosaurus* sp. No. 5380, U. S. National Museum. Originally described by Cope as *Placosaurus*.
12. Proximal portion of femur, ventral view. Natural size.
12a. Distal end of right femur, ventral view. Natural size.
12b. The same, end view.
12c. Distal end of quadrate. Natural size.
12d–12j. Dermal scutes, dorsal view. × 2.
(After Cope.)
13. *Cteniogenys antiquus* Gilmore. Type. No. 6134, U. S. National Museum. Median portion of dentary, outer view ×3.
14. *Cteniogenys antiquus* Gilmore. Paratype. No. 1068, Yale Museum. Anterior portion of right dentary, inner view. ×3.

PLATE 21

Fig. 1. *Peltosaurus granulosus* Cope. No. 11393, Princeton Museum. Skull and lower jaws, dorsal view. ×2.5.

2. The same, right lateral view.
3. *Peltosaurus granulosus* Cope. No. 1061, Yale Museum. Skull and lower jaws, viewed from the right side. ×2.5.



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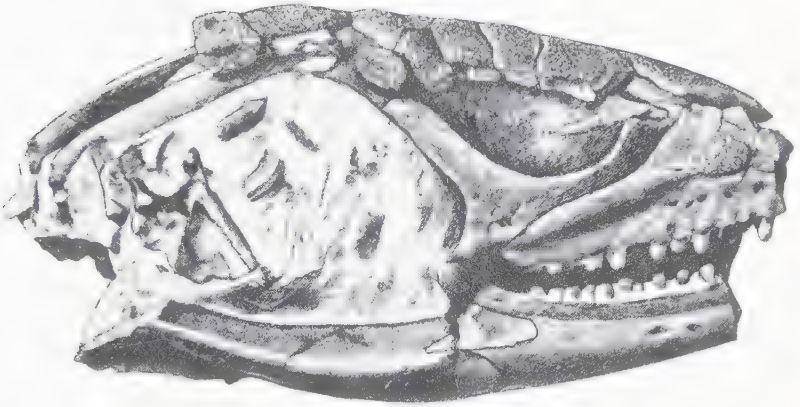

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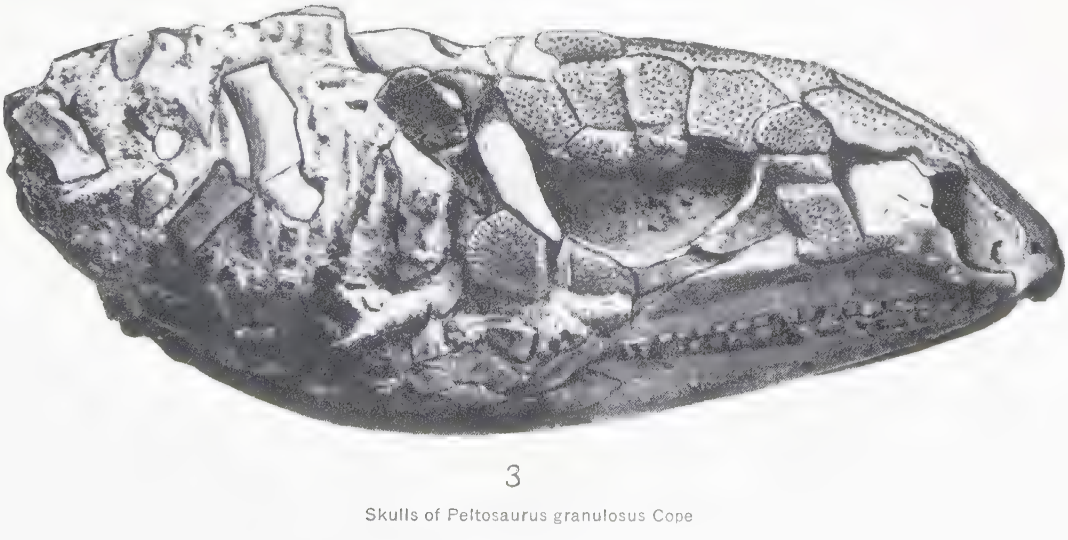

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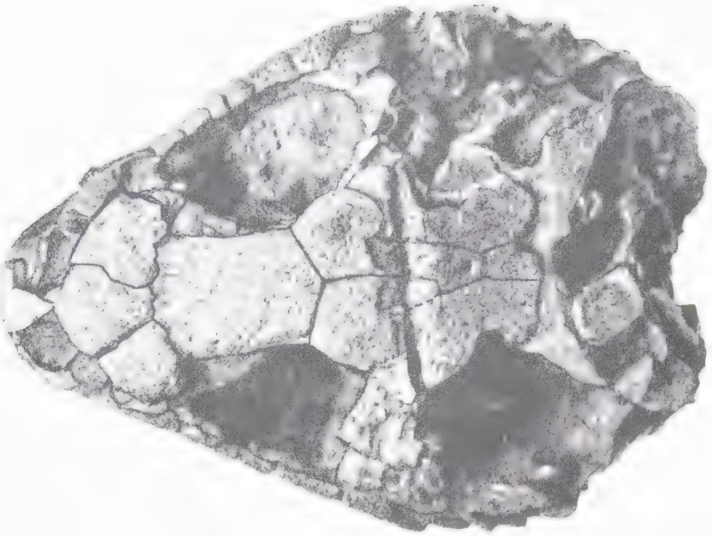
Skulls of Peltosaurus granulosus Cope



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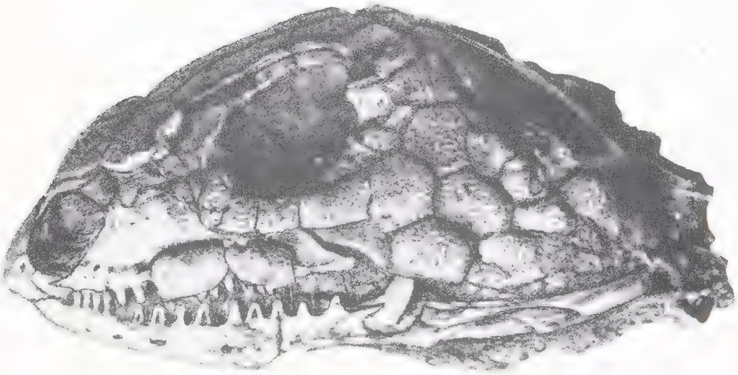

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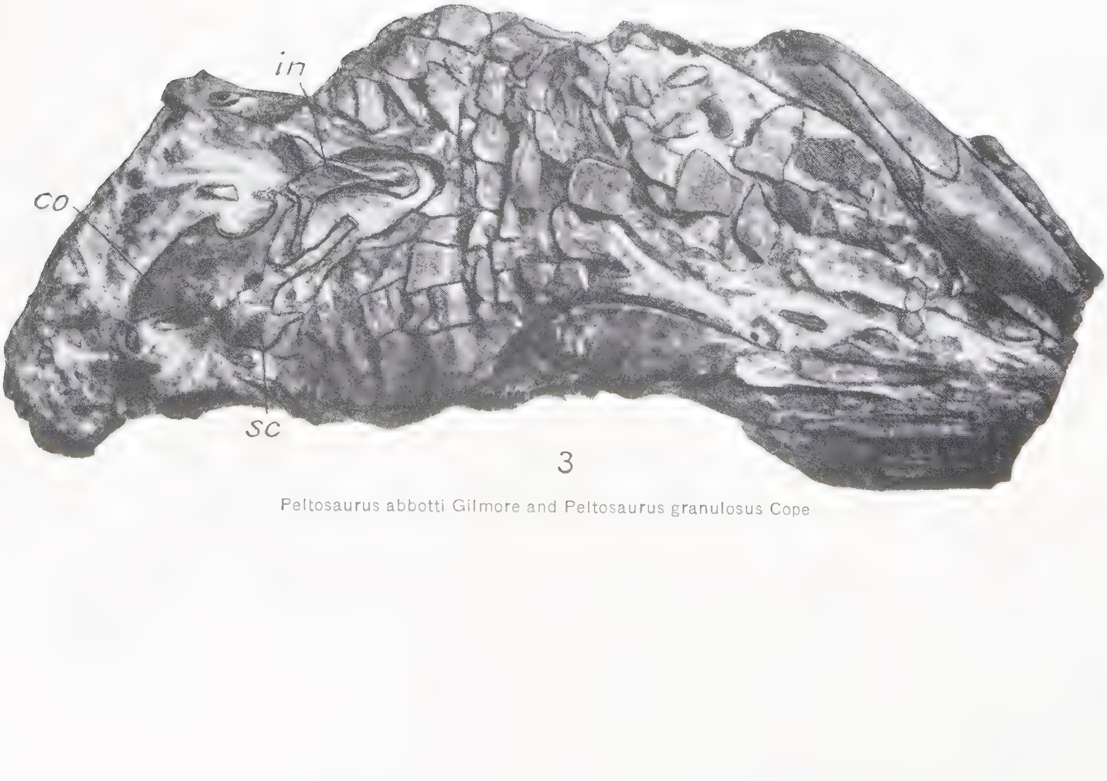

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Peltosaurus abbotti Gilmore and Peltosaurus granulosus Cope

PLATE 22

Fig. 1. *Peltosaurus abbotti* Gilmore. Type. No. 12861, Field Museum of Natural History. Skull and lower jaws, dorsal view. ×2.

2. The same, lateral view from the left side.

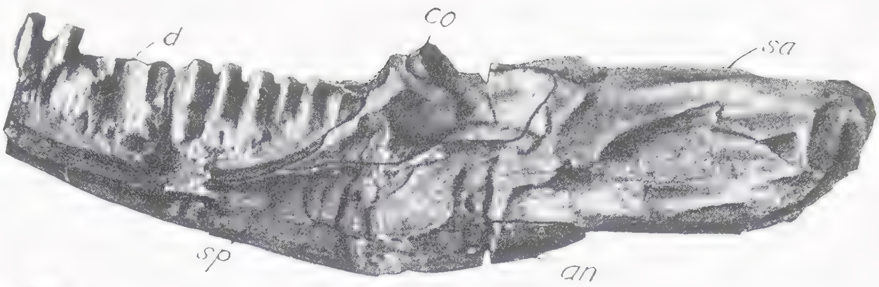
3. *Peltosaurus granulosus* Cope. No. 391, Walker Museum. Portion of skull, lower jaws, pectoral girdle, and dermal scutes. Ventral view. ×2.

co, coracoid; *in*, interclavicle; *sc*, scapula.

PLATE 23

FIGS. 1–4. *Melanosaurus maximus* Gilmore. Type. No. 5168, American Museum of Natural History.

1. Crushed skull and lower jaws, dorsal view. *ar*, articular; *co*, coronoid; *f*, frontal; *ju*, jugal; *p*, parietal; *pf*, prefrontal; *po*, postorbital; *ptf*, postfrontal; *qu*, quadrate; *sa*, surangular; *sq*, squamosal; *ta*, tabulare. ×2.
2. Right ramus, inner view. *an*, angular; *co* coronoid; *d*, dentary; *sa*, surangular; *sp*, splenial. ×2.
3. Anterior caudal vertebra, ventral view. ×2.
4. Caudal vertebra; ventral view. ×2.



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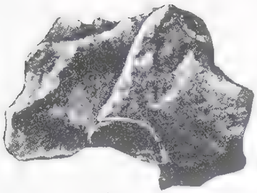

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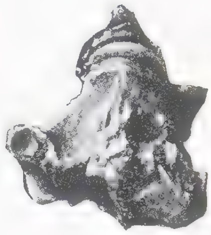

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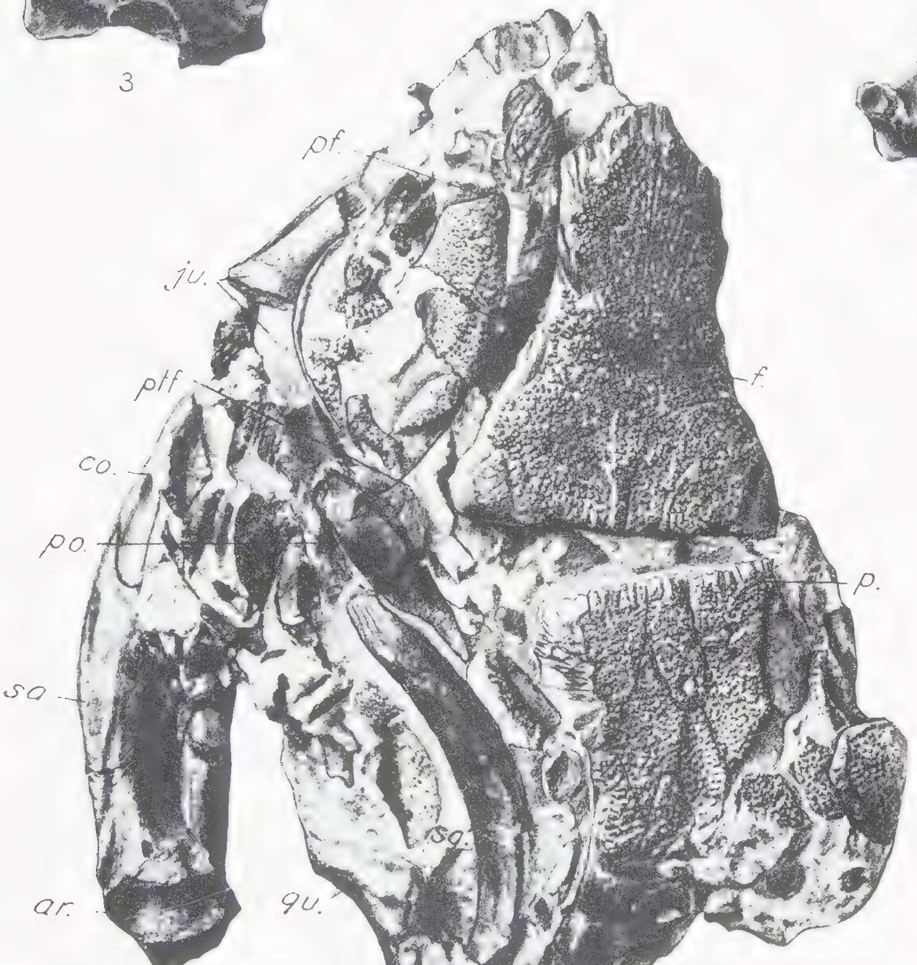

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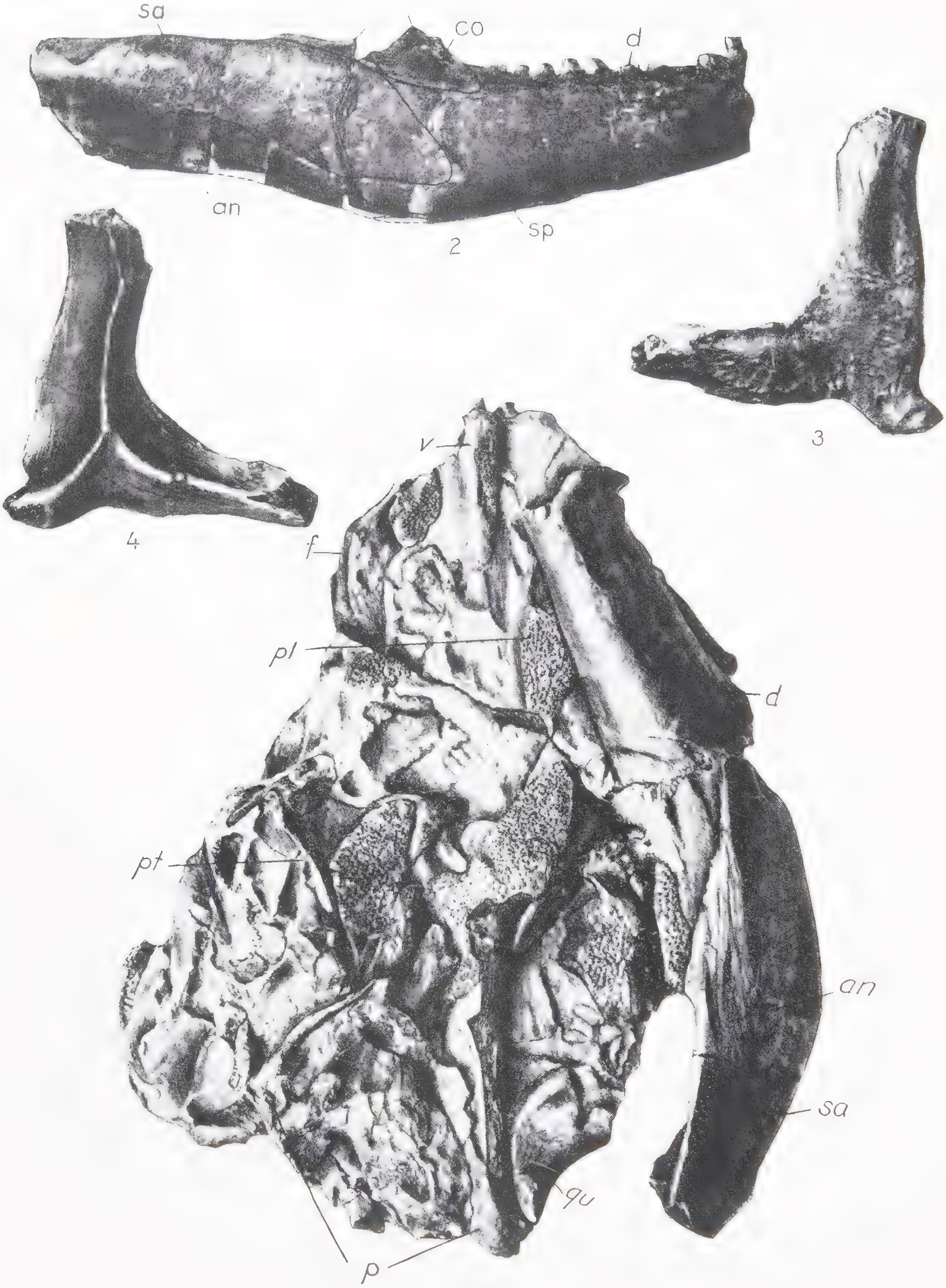
Melanosaurus maximus Gilmore



Melanosaurus maximus Gilmore

PLATE 24

Figs. 1–4. *Melanosaurus maximus* Gilmore. Type. No. 5168, American Museum of Natural History.

1. Crushed skull and lower jaws; ventral view. *an*, angular; *d*, dentary; *f*, frontal; *p*, parietal; *pl*, palatine teeth; *pt*, pterygoid teeth; *qu*, quadrate; *su*, surangular; *v*, vomerine teeth. ×2.
2. Right lower jaw, outer view. *an*, angular; *co*, coronoid; *d*, dentary; *sa*, surangular; *sp*, splenial. ×2.
3. Left jugal, outer view. ×2.
4. The same, inner view.

PLATE 25

FIG. 1. *Cremastosaurus unipedalis* (Cope). Type. No. 1605, American Museum of Natural History. Sacral vertebra, neural arch absent; dorsal view. Natural size.

1a. The same, ventral view.

1b. The same, anterior view.

(All after Cope.)

2. *Diacium quinquepedale* Cope. Type. No. 1602, American Museum of Natural History. Sacral vertebra, anterior view. Natural size.

2a. The same, ventral view.

2b. The same, dorsal view; posterior part of arch broken away.

2c. The same, from the right side.

(All after Cope.)

3. *Cremastosaurus carinicollis* Cope. Type. No. 1604, American Museum of Natural History. Five anterior cervical vertebrae including axis; dorsal view. ×2.

3a. The same, diagonally from below. Slightly more than ×3.

3b. The same, ventral view. ×2.

3c. The same, posterior view. ×2.

(All after Cope.)

4. *Exostinus serratus* Cope. Type. No. 1608, American Museum of Natural History. Median portion of right dentary with teeth, inner view. ×3.

5. Frontal bone of same, dorsal view. ×3.

5a. The same, ventral view.

6. Right jugal of same, from side.

7. *Troödon formosus* Leidy. Type. Premaxillary tooth, side view. ×3. (After Leidy.)

8. *Cremastosaurus rhambastes* (Cope). Type. No. 1606, American Museum of Natural History. Dorsal vertebrae, from left side. ×2.

8a. The same, ventral view.

8b. The same, posterior view.

8c. Anterior view of another individual. ×2.

(All after Cope.)

9. Amphisbaenoid? atlas and axis, possibly referable to *Rhineüra hatcherii.* No 11391, Princeton Museum. Ventral view. ×4.

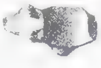
10. *Rhineüra coloradoensis* (Cope). Type. No. 1607, American Museum of Natural History. Dorsal vertebrae, viewed from left side. ×2. (After Cope.)

10a. The same, anterior view. (After Cope.)

10b. The same, ventral view. ×3.

10c. The same, dorsal view. ×2. (After Cope.)

11, 12. *Rhineüra coloradoensis* (Cope) No. 989, American Museum of Natural History. Articulated series of cervical and dorsal vertebrae, ventral view. ×2.



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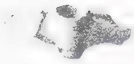

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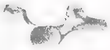

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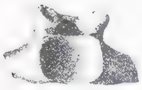

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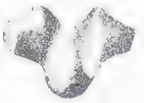

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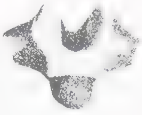

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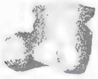

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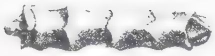

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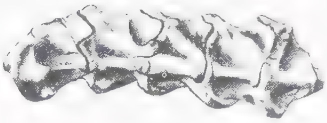

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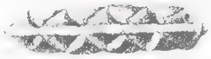

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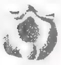

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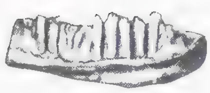

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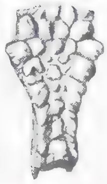

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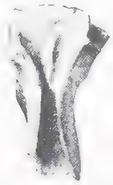

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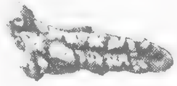

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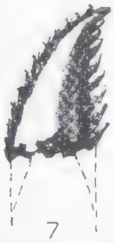

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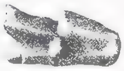

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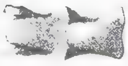

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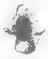

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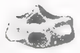

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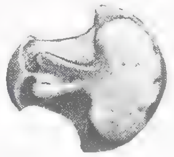

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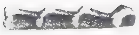

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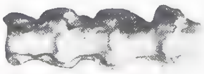

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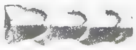

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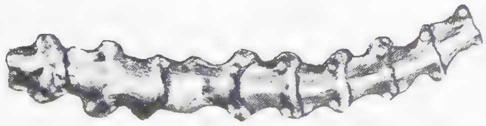

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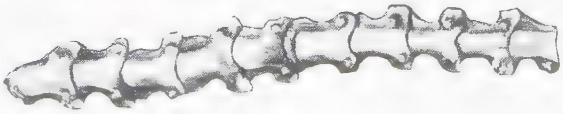

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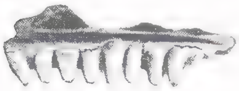
Various Extinct Lizards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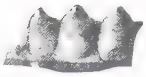
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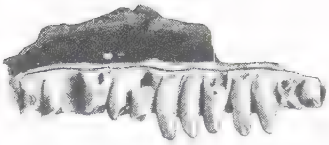
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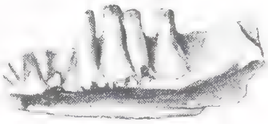
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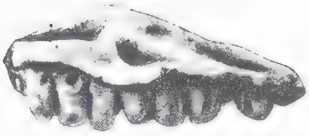
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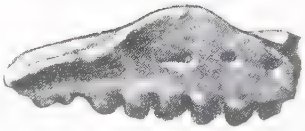
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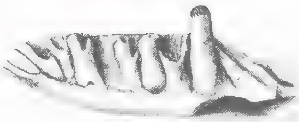
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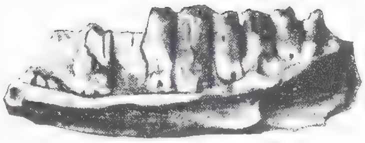
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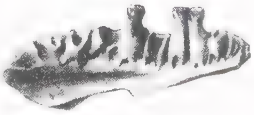
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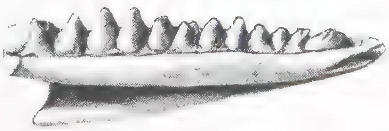
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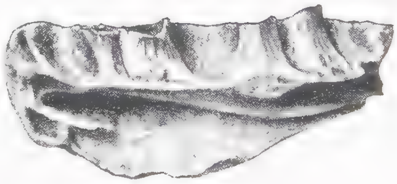
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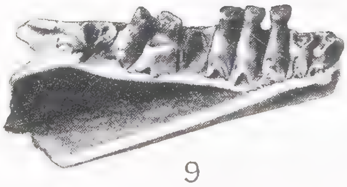
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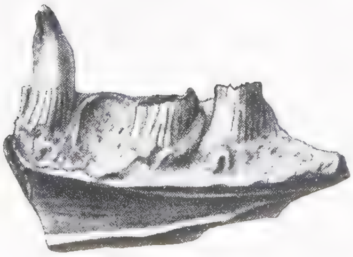
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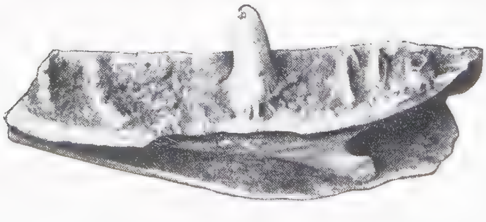
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Upper Cretaceous (Lance) Lizards

PLATE 26

FIG. 1. *Prionosaurus regularis* Gilmore. Type. No. 10750, U. S. National Museum. Incomplete right (?) maxillary containing 8 teeth; inner view. About ×5.

2. *Exostinus? lancensis* Gilmore. Type. No. 10689, U. S. National Museum. Maxillary containing 5 complete teeth; inner view, About ×5.

3. *Odaxosaurus obliquus* Gilmore. Type. No. 10751, U. S. National Museum. Median portion of right dentary containing 4 complete teeth; inner view. Slightly less than ×5.

4. *Peltosaurus? piger* Gilmore. Paratype. No. 10688. U. S. National Museum. Left maxillary containing 7 teeth; inner view. About ×5.

4a. The same, outer view.

5. *Odaxosaurus obliquus* Gilmore. No. 10804, U. S. National Museum. Right dentary, internal view. Slightly more than ×5.

6. *Peltosaurus? piger* Gilmore. Type. No. 10687, U. S. National Museum. Posterior portion of right dentary containing 6 teeth; inner view. About ×5.

6a. The same, inner view.

7. *Habrosaurus dilatus* Gilmore. No. 10816, U. S. National Museum. Left dentary containing 3 teeth; inner view. Slightly less than ×5.

8. *Lanceosaurus hatcheri* Gilmore. Type. No. 10706, U. S. National Museum. Left dentary containing teeth; inner view. ×5.

9. *Habrosaurus dilatus* Gilmore. Type. No. 10749, U. S. National Museum. Left dentary carrying 5 teeth; inner view. ×5.

10. *Parasaniwa obtusus* Gilmore. No. 10800, U. S. National Museum. Left maxillary; inner view. ×5.

11. *Parasaniwa wyomingensis* Gilmore. Type. No. 10797, U. S. National Museum. Portion of left dentary carrying one complete tooth; inner view. ×5

12. *Parasaniwa obtusus* Gilmore. Type. No. 10798, U. S. National Museum. Right dentary carrying one tooth; inner view. ×5.

13. *Alethesaurus quadratus* Gilmore. Type. No. 10802, U. S. National Museum. Portion of jaw bearing 3 teeth; inner view. ×4.

PLATE 27

Fig. 1. *Megasaurus robustus* Gilmore. Type. No. 2910, U. S. National Museum. Anterior caudal vertebra; ventral view. ×2.

1a. The same, viewed from the left side.

2. Parietal of an undertermined lizard. No. 10725, U. S. National Museum; dorsal view. ×4.

2a. The same, ventral view.

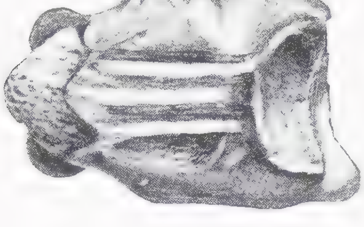
3. *Megasaurus robustus* Gilmore. No. 1063, Yale Museum. Parietal; dorsal view. ×3.

4. *Phrynosoma* sp. No. 6405, American Museum of Natural History; inner view. About ×4.

5. *Chamops denticulatus* Gilmore. Type. No. 1062, Yale Museum. Left dentary; inner view. About ×2.

6. *Crotaphytus* sp. No. 10690, U. S. National Museum. Portion of left dentary containing teeth; inner view. About ×5.

7. *Melanosaurus*? sp. No. 6167, American Museum of Natural History. Block containing dermal scutes and other bones; ventral view. About natural size. *co*, coracoid; *d*, dentary.



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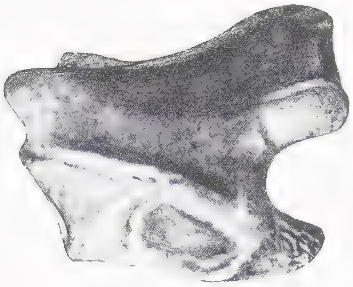

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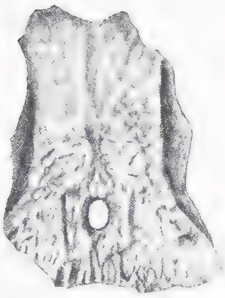

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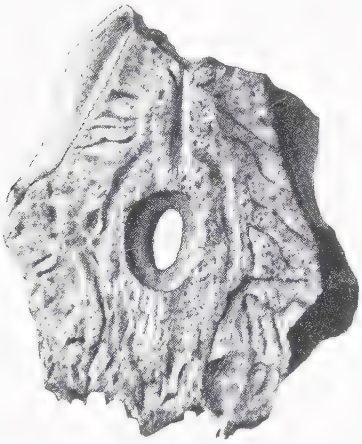

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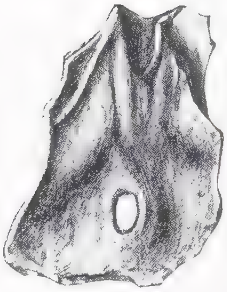

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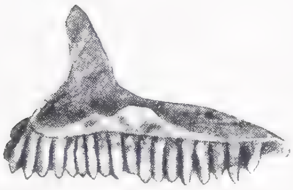

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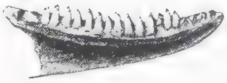

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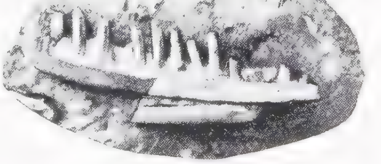

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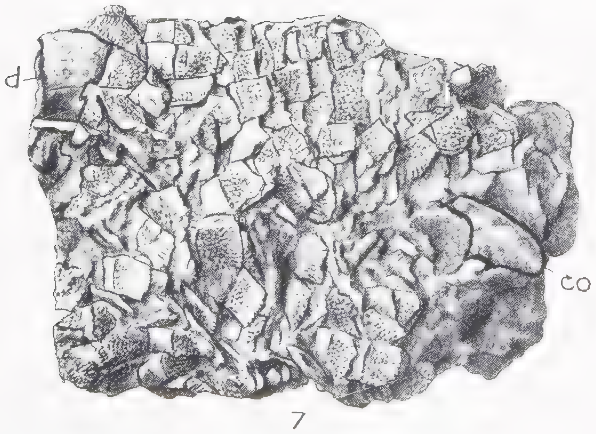

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Various Extinct Lizards

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